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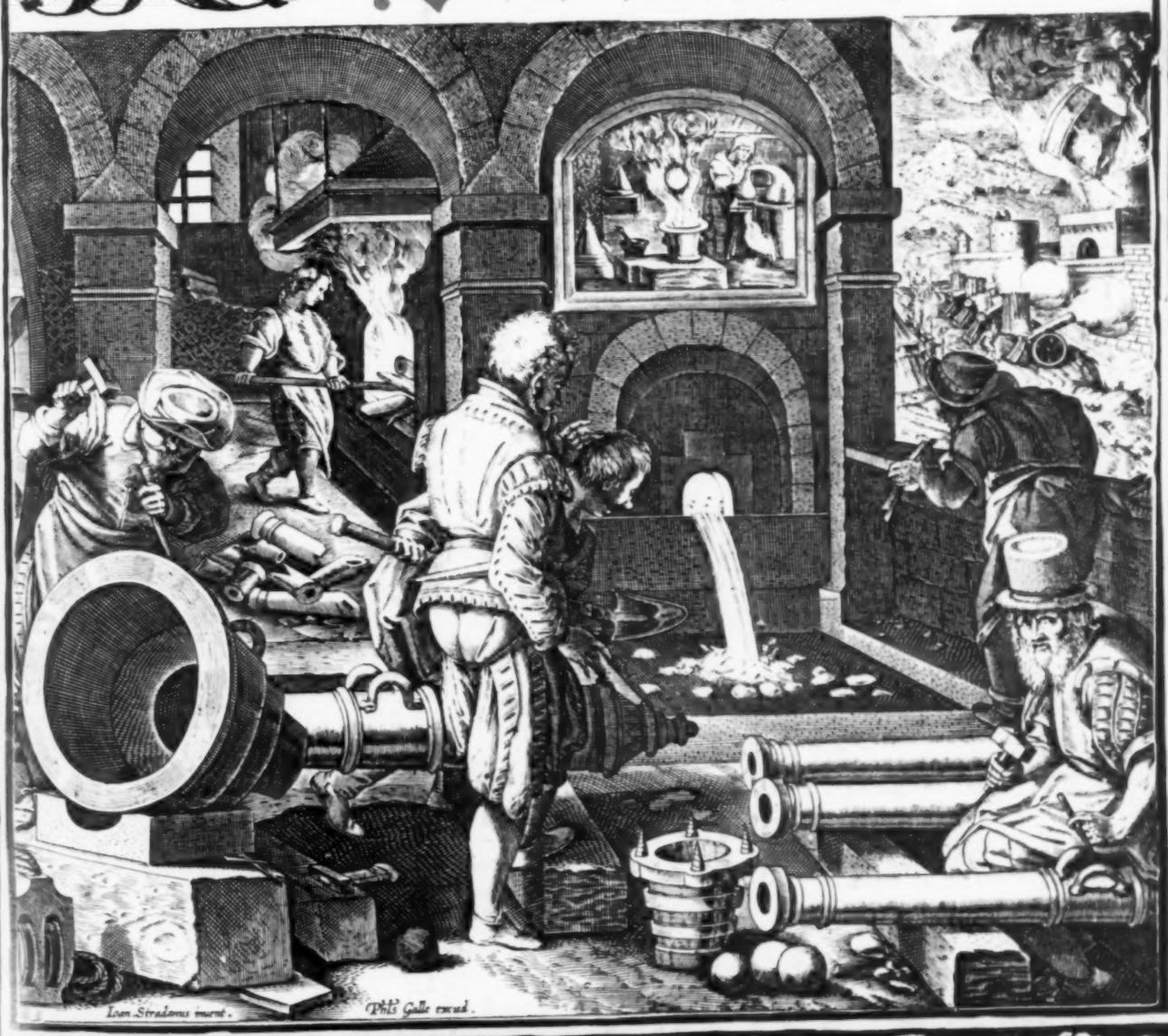

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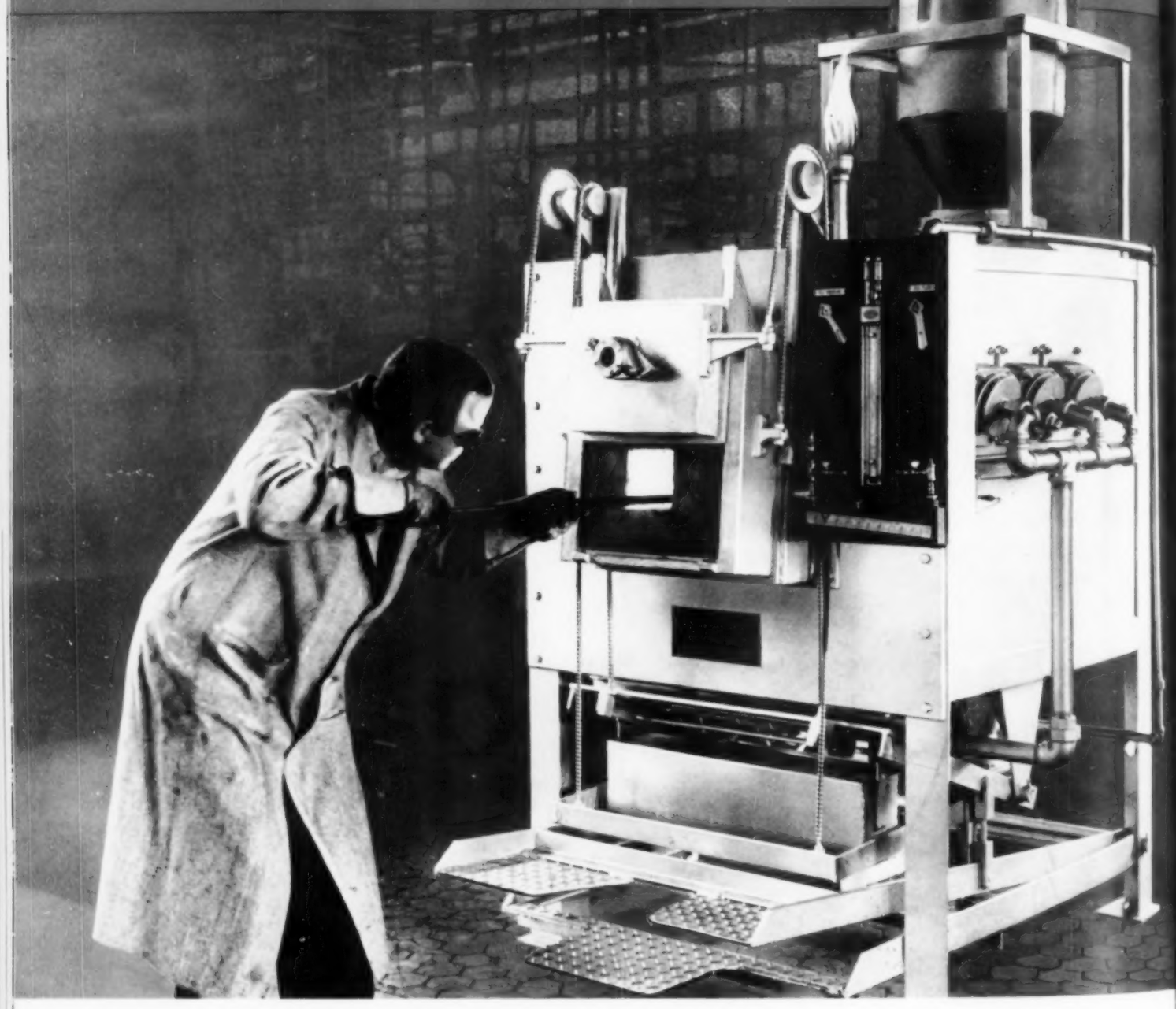

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contents of

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December, 1938

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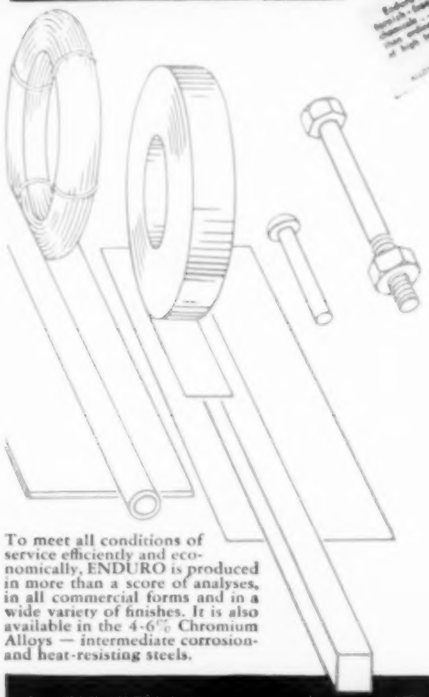

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By Louis J. Larson
Consulting Engineer
Milwaukee, Wisc.

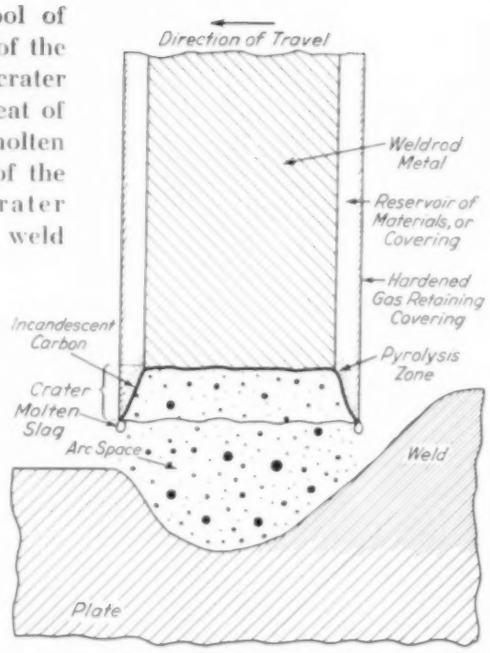
metallurgical aspects of Welding

UNTIL a designing engineer becomes familiar with the properties of the modern type of weld metal he quite logically asks the question, "How shall I figure the weld?" and "How much must I allow for the uncertainty in the strength of the weld metal?" This skepticism and lack of confidence in the behavior of weld metal is sometimes the result of past experiences with welds which were not satisfactory. Many engineers are personally familiar with welds that failed for no apparent reason. To have confidence in welding the engineer must be satisfied, not only that good welds *have* been made, but that such welds can be produced consistently and that welds of inferior quality do not occur by chance. As a matter of fact, investigations of various types of weld metal reveal that the inherent characteristics of the metal are dependent, to a great extent, on the welding procedure used.

For our present purpose, metallic arc welding of mild steel may be divided into two groups or procedures: (1) The old art in which bare or lightly coated electrodes are used and (2) the modern type of welding with heavily covered electrodes. In either case the deposited weld metal is steel and the welding process is a steel making process. Although it is well known that the molten metal produced in the steel furnace must be properly protected from exposure to the air, this principle was overlooked or ignored in the early days of metallic arc welding. Whereas in the manufacture of steel the molten metal is protected by a blanket of slag and by a proper furnace atmosphere, it is practically impossible to use slag alone for protecting the metal in the usual arc welding process because the metal passes across the arc from weldrod to weld in the form of small globules or drops. Due to the large ratio of surface to volume of these small globules the metal picks up oxygen and nitrogen very rapidly, at the temperature of the arc, and protection therefore becomes doubly important during transfer. This protection has been accomplished by the use of coverings on electrodes or weldrods.

In the following discussion the data given pertain to a particular type of electrode having a cellulosic covering which contains cellulose, ferromanganese, silica flour, kaolin and sodium silicate. The diagram on the next page shows, schematically, such an electrode in operating position over the work. In the arc space the metal core melts and the molten metal passes across in the form of tiny spheres of steel; the heat of the arc also disintegrates the coating. A portion of the covering is gasified and the remaining portion melts and floats

as a slag on the molten pool of metal below. Under the end of the electrode may be seen the crater formed in the plate by the heat of the arc. The mixture of molten metal derived from the end of the electrode and from this crater builds up a sizeable bead of weld metal behind the arc.

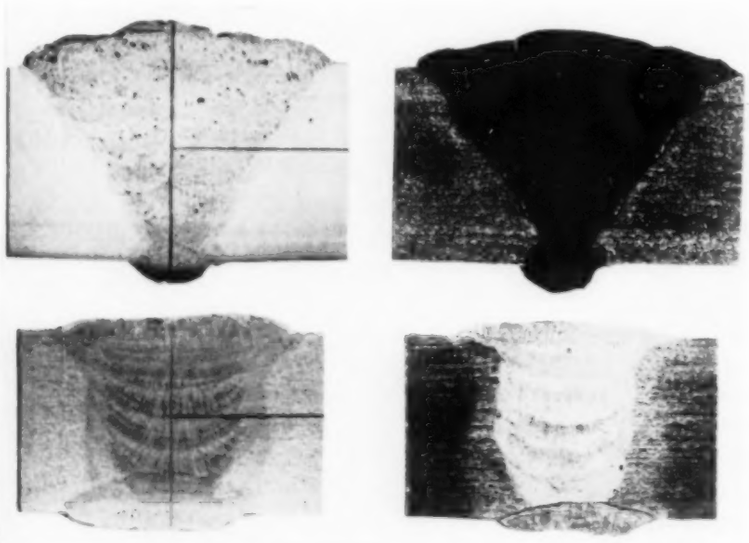


Since Metal Is Transferred From Electrode to Weld Through a Stable Arc in a Shower of Tiny Drops It Is Doubly Important to Protect it From Reaction With Atmospheric Oxygen and Nitrogen

The quantities of the various gases liberated by one centimeter of a ¼-in. covered electrode of this particular type are as follows: Hydrogen 85.4 cu.cm., carbon monoxide 70.3 cu.cm., water vapor 9.3 cu.cm., carbon dioxide 1.9 cu.cm. (all measured at 100° C. and 760 mm. pressure). Both of the principal gases, H_2 and CO, are highly reducing and hence very effective in preventing oxidation of the molten metal. The volume of the electrode which produced these gases is about 0.5 cu.cm., and the total volume of gases is approximately 300 times the volume of the electrode even when measured at 100° C., and at the temperature of the arc their volume is several times greater. This large amount of gas rushing out of the arc space prevents the air from coming in contact with the metal in the arc; it also flows over the molten pool and the surrounding surface, as shown by the flame around the arc. The effectiveness of the protection afforded by the coating is shown by studies of weld metal produced by covered electrodes as compared with metal deposited with a bare electrode. These studies include metallurgical examination, gas analyses, and physical tests.

Large Differences in Corrodibility

A comparison of a polished section across each type of weld shows no significant difference. Both welds appear to be sound and are not readily distinguished from the adjacent plate. After etching, differences become apparent. The accompanying group of macrographs shows both types full size as they appear after a light etch (left) and after a deep etch (right). Lightly etching the bare wire weld shows a number of small black areas or spots which are not present in the weld made with the covered electrode. Some of these represent actual voids and others are iron oxide entrapped in the metal. After a deep etch the bare wire weld shows severe attack whereas the weld made with the covered electrode shows less attack than the plate. The degree of attack in the deep etch often indicates the susceptibility to corrosion, and service records have shown that bare wire welds are frequently unsatisfactory for corrosion whereas welds made with properly covered electrodes are often less corrodible than the base metal.

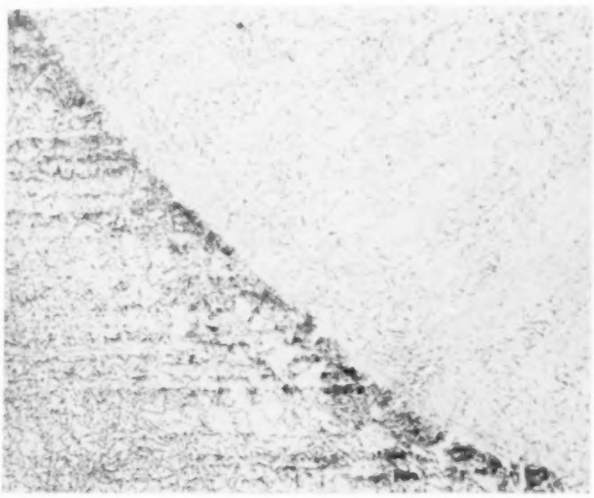


Full Size Sections Through Welds in 1-In. Plate. Welds with bare wire above, with covered electrode below. Sections lightly etched at left; deeply etched at right

Next is a pair of micrographs showing the junction of each

type of weld metal with the plate at 100 diameters. The difference is very pronounced. The junction of the bare wire weld is well defined and the structures on the two sides of the junction are dissimilar. In the micro at right the junction extends from the upper left to the lower right hand corner and the weld is in the upper right hand triangle. There is no evident difference between the weld and the plate and the structure is continuous across the junction. With this continuity of structure there is no reason to fear a weakness at the junction of the plate and weld.

The chemical analyses of the two types of weld and of the plate material are given in the table at the bottom of the page. So far as the elements carbon, manganese, silicon, phosphorus and sulphur are concerned there is nothing alarming about either weld. The carbon, manganese and silicon of the bare wire weld are very low and the weld resembles pure iron, and should have rather low strength values and be very ductile. The weld made with covered electrodes has an analysis corresponding to that of a low carbon, silicon killed steel; it should have good strength and good ductility.



Junction of Plate and Weld Metal at 100 Diameters, After Stress Relieving at 1200° F., Sectioning, Polishing and Etching With 2% Nital. Note nitride "needles" — short black marks — in weld metal from bare wire (at left). Junction is hardly descernible in weld made with covered electrode (right)

Gas Content

Further examination of these structures at higher magnification indicates the presence of many nitride "needles" in weld metal from bare wire. Annealing at 1700° F. will precipitate the nitrogen and intensify the appearance; similar treatment of the weld made with covered electrodes does not show these needles.

A view of a bare wire weld at 1000 diameters is also shown on page 660. The short, minute cracks shown in this view joining some of the inclusions are no doubt caused by shrinkage stresses during cooling. Although these cracks are very small they probably have a pronounced effect on the joint's resistance to repeated stress and are also responsible for the erratic strength values of bare wire weld metal deposited in joints in heavy plates.

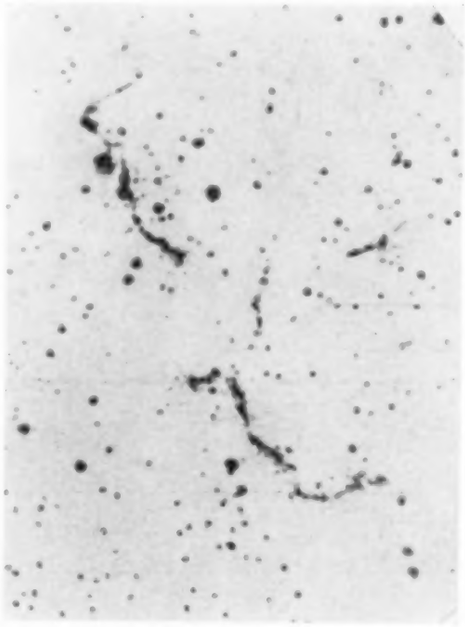
When the oxygen and nitrogen contents are considered, significant differences between the materials are found. The bare wire weld has about 12 times as much oxygen and 33 times as much nitrogen as the plate. The weld made with the covered electrodes has four times as much oxygen and 2½ times as much nitrogen as the plate.

Chemical and Gas Analysis of Welds and Plate

Element	Welds From		In Plate
	Bare Wire	Covered Electrode	
Carbon	0.02	0.08	0.19
Manganese	0.09	0.57	0.56
Silicon	0.01	0.25	0.01
Phosphorus	0.012	0.012	0.028
Sulphur	0.027	0.023	0.022
Oxygen	0.298	0.072	0.024
Nitrogen	0.131	0.010	0.004

It is well known that both nitrogen and oxygen affect the properties of steel. When present in sufficient amount, nitrogen increases the strength, decreases the ductility and makes the steel susceptible to age hardening. F. R. Hensel and E. I. Larsen found from their tests on weld metal, published in *Transactions*, A.S.S.T., 1932, page 639, that the nitrogen content must be below 0.05% to eliminate the age hardening tendency. Oxygen, if in the form of FeO, tends to increase the strength and decrease the ductility of steel and also makes the metal hot short. Since only the total oxygen is shown in the table no comparison of the FeO content can be made without further data.

To determine the amount of oxygen combined with each of various elements requires an analysis by the fractional vacuum process. The final diagram shows the results of such analyses. The oxygen is divided into three fractions: (1) Oxygen joined with the bases iron and manganese; (2) iron joined with the acid silicon; (3) iron joined with the neutral aluminum. It will be seen that not only is the total oxygen content for the bare wire weld very large but nearly all of it is in the first fraction as iron and manganese oxides. Since the weld contains 0.09% Mn it can have only 0.03% oxygen in the form of MnO assuming *all* of the Mn is oxidized. Hence the oxygen in the form of FeO must be at least 0.25%. A study of the fractional analysis of the weld made with covered electrodes shows that the first fraction is very small — in fact smaller than the corresponding fraction of the plate. Most of the oxygen of this weld is in the second fraction, that is, combined with silicon as SiO_2. In this form it has not been found to be harmful and there are indications that it is beneficial in certain respects.



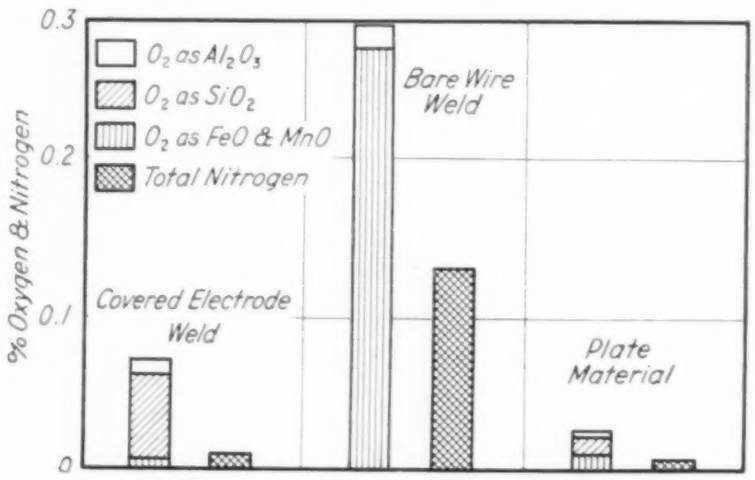
Shrinkage Cracks in Weld Made With Bare Wire. Polished section, not etched, at 1000 diam.

From the chemical analyses given in the table and the fractional vacuum analyses in the figure, it is apparent that the bare wire weld is high in nitrogen and FeO and the weld made with covered electrodes is low in both these constituents.

Metallurgical and physical tests show that each type of weld metal behaves in a manner consistent with its microstructure and chemical analysis. Welds made with bare wire are hot short and show age hardening; those made with covered electrodes show neither effect. The mechanical properties of both welds are shown in the accompanying table, and corresponding properties of the plate are given for comparison.

The strength values of bare wire welds in ¼-in. plates are sufficient but the ductility values are not satisfactory for certain purposes. In heavy plates, 1 in. and more in thickness, the strength is uncertain and the values for ductility are low and may be zero; the Charpy values are also very low.

Welds made with covered



Fractional Gas Analysis Shows That Most of the Oxygen in a Bare Wire Weld Is Held as Iron Oxide, Whereas It Is as Silica in the Covered Electrode Weld

Mechanical Properties of Welds and Plate

Type of Electrode	Plate Thickness	Condition	Yield Point	Ultimate Strength	Elongation in 2 In.	Reduction of Area	Bend Elongation	Charpy Impact
Bare	¼ in.	As welded	40,000 to 45,000	50,000 to 60,000	6 to 15%		15 to 30%	
Bare	1 in.	Stress relieved	20,000 to 45,000	25,000 to 55,000	1 to 7%	0 to 7%	1 to 12%	1 to 2 ft-lb.
Covered	¼ in.	As welded	40,000 to 55,000	55,000 to 70,000	20 to 30%		>30%	
Covered	1 in.	Stress relieved	40,000 to 55,000	55,000 to 70,000	25 to 40%	40 to 70%	>30%	25 to 45
Covered	>1 in.	Stress relieved	40,000 to 55,000	55,000 to 70,000	25 to 40%	40 to 70%	>30%	25 to 45
0.20 to 0.30% C steel plate		As rolled	30,000 to 40,000	55,000 to 65,000	35 to 50%	50 to 70%		20 to 30

electrodes have ultimate strength and ductility values about the same as mild steel for all thicknesses of stock, and the yield point and Charpy impact values of these welds are higher than those of the rolled plate.

High Strength Steels

The above results apply to mild steel. Frequently the engineer is called upon to design structures of steels having a higher strength than that of plain carbon steel, and information on the properties of welds in such steels is necessary. The last table gives a range of mechanical properties of welds suitable for several low alloy steels and also two of the commonly used stainless steels. The welds are intended to have about the same ultimate strength as the corresponding plate material. The resulting yield points are higher than those of the plate. The decrease of ductility with increase of strength of the weld metal shown in this table is also characteristic of rolled material; elongations for the welds on the various materials are of the same general range as the corresponding values for the plate and are ample for safety.

A number of high strength steels designed especially for welding have been developed in recent years. For their strength these steels depend upon such alloys as manganese, silicon, copper, nickel, chromium, molybdenum and vanadium, and the carbon content is kept low to reduce the air hardening tendency. In the welding of high strength alloys greater precautions are often more necessary than in the welding of mild steel but under proper conditions excellent results are obtained.

Summarizing, the results of tests on welds show that, from a metallurgical standpoint, those made with bare wire are very different from welds made with covered electrodes; inherent properties of weld metal therefore depend upon the welding process used.

In the design of welded structures the engineer must recognize the properties of each of these types of weld metal. In the welding of light gage material into structures in which ductility is of little importance bare wire may sometimes be used with satisfactory results, but even for such applications it is not always the most economical. For the welding of heavier materials and for all structures in which ductility and toughness are important covered electrodes are required.

With the proper type of covered electrodes and modern welding technique, welds having mechanical properties equivalent to the plate materials may be obtained in mild steel and in many of the alloy steels. In computations such welds are treated as though they were plate material similarly located. Of course, the actual cross section of the metal must be used in computing stresses and the proper allowance must be made for stress concentration due to changes in section. For some types of structures the allowable stresses are specified by codes. In other cases the welds may be stressed to the same values as the base metal.

Welds in Some Alloy Steels

Alloy Steel		Yield Point	Ultimate Strength	Elongation in 2 In.
Type	Analysis			
Carbon-molybdenum	Mo 0.40 to 0.60%	50,000 to 60,000	70,000 to 80,000	22 to 32%
Nickel	Ni 2.0%	55,000 to 65,000	70,000 to 80,000	20 to 30
Chrome-vanadium	Cr 1.0%, V 0.20%	65,000 to 80,000	85,000 to 100,000	15 to 25
Chromium	Cr 4 to 6% Mo 0.40 to 0.60%	40,000 to 50,000	70,000 to 80,000	25 to 35
Stainless	Cr 16 to 18%	50,000 to 60,000	80,000 to 90,000	15 to 25
Stainless	Cr 18%, Ni 8%	40,000 to 50,000	70,000 to 80,000	20 to 50

Modern Machining

Fixture in Double-Head Mill for Boring and Threading Several Parallel Holes in Scale Lever With High Degree of Accuracy. Photograph made at Toledo Scale Co.

By Samuel F. Newman
Vice-President
Landis Machine Co.
Waynesboro, Pa.

notes on

threading tools:

Chasers

THE ORIGINAL TERM covering thread cutting tools was "dies", and was applied to solid dies or heads when the thread cutters were backed off or out of the work after threading. With the advent of self-opening die heads and collapsible taps the nomenclature for the individual thread cutting tools became "chasers". This term is now generally applied to the individual pieces that go to make up a complete set for cutting internal or external threads — a set consisting of three or more chasers fixed in a die head or collapsible tap.

Hobbed, milled, circular, and tangential types of chasers are made (as shown in the sketch on the next page). All these types are well known to users of screw thread cutting equipment for external threading. For internal threading, hobbed and circular types only are used.

Chasers are called upon to cut screw threads on all types of machinable steels, cast iron, non-ferrous metals, wood, rubber, and limitless compositions such as plastic materials.

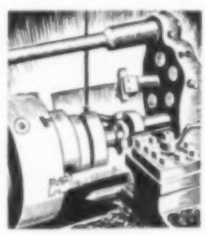
The entire range of machinable hardness may be encountered in any one analysis or type of steel. In heat treated alloy steels the average hardness will approximate 285 Brinell. Top hardness limit for commercial threading is approximately 340 Brinell.

High speed steel of the 18% tungsten, 4% chromium, 1% vanadium ("18-4-1") type is recognized as the best all-around high speed steel for screw thread cutting. Steels such as 14-4-2; 18-4-2; 14-4-2 high speed with 4% cobalt; and high speeds where much or all of the tungsten is replaced by molybdenum, such as 8% molybdenum, 4% chromium and 2% vanadium; and 8% molybdenum, 2% tungsten, 4% chromium and 1% vanadium are used to advantage on specific applications.

For threading copper and other low strength non-ferrous metals, 1.20% carbon toolsteel, oil hardening toolsteel, or Stellite-tipped chasers are frequently used.

High speed steel for threading chasers is usually purchased to a rather restricted carbon range. For instance, the 0.70% carbon grade of 18-4-1 is held to 0.68 to 0.72% carbon. When threads are cut in bars of high speed steel at right angles to the direction of rolling, as is usually the case with the hobbed or milled type chaser, carbide segregation must be at a minimum in the bar; each end of every bar may be polished and etched for inspection as to this feature. Incidental impurities as nickel, cobalt, molybdenum, copper or arsenic should be sufficiently low individually or as totals with complementary impurities so as to have no harmful effect on the general properties of the toolsteel. The steel should show no abnormal tendency to "sweat", carburize or decarburize during heating for hardening.

Close temperature control of all heating operations is requisite. The wide variety of dimensions as to chaser size, the variations in pitches and types of threads (such as U.S.S., Whitworth, S.I., Acme, and so on) variation as to surface finish (whether the tools are ground all over or not after hardening), and the various tolerances allowed by the application or the purchaser, suggest the use of various types of heating equipment. Oil-fired and gas-fired semi-muffle furnaces are satisfactory for hardening some types of chasers. Controlled atmosphere furnaces, invariably electrically heated, are used extensively and are generally more satisfactory than semi-muffle furnaces. Salt baths appear to be the most satisfactory method for treating the molybdenum steels insofar as maintaining a surface free from decarburization is concerned.



Quenching Practices Are Various

A wide variety of heat treatments have been and to some extent are still applied to the hardening of chasers. The most generally used temperatures for 18-4-1 steel are: Preheat 1500 to 1550° F., high heat to 2300 to 2350° F. Chasers may be quenched (1) in natural air, (2) on a water-cooled copper plate, (3) under a soft air blast, (4) in molten salt at 1100 to 1200° F. and finish cooling in air, (5) in molten salt at 1400° F. then into another salt at 600 to 700° F. and finish cooling in air, or (6) in oil. Any of the methods are used on occasion, the size, type of chaser, nature of thread, size tolerances and allowable distortion dictating the practice that is adopted.

Salt baths or forced convection air furnaces are used for drawing the chasers. Temperatures used are 1000 to 1200° F. (actually 1050 to 1100° F. is the usual range).

The hardness to which chasers are drawn is compromised by a number of factors such as (1) composition and nature of materials to be threaded, whether cut or sheared stock, wrought iron pipe, cast iron pipe, and so on, (2) type of grind necessary to produce quality of finish desired, (3) type of throat required whether long, short or none, (4) condition of equipment.

Chasers are tempered to as low as Rockwell C-54 to 55 for some few Acme thread applications, and as high as Rockwell C-64 to 66 for the hard grades of seamless steel tubing.

Nitriding the finished hardened (or finished hardened and ground) chasers by means of a molten mixture of sodium and potassium cyanides or by one of the proprietary nitriding salt baths is frequently done. The results obtainable do not appear to be predictable, experience having shown a number of successes as well as failures. The nitriding, conducted at 1000 to 1100° F., may vary from a 5-min. immersion to reduce the affinity of the tool surface for the metal being cut, to long soaking periods for high surface hardness.

Most threading of iron and steel is done wet. Below are listed the coolants most generally used.

Lap welded and butt welded pipe, wrought iron and soft steels: Soluble oil and water are used, but sulphur base oil is recommended.

Heat treated steel and seamless steel tubing: Sulphur base oils.

Cast iron: Soluble oils or kerosene mixtures.

Brass and bronze: Threaded dry, or with soluble oils or paraffin oils.

Aluminum: Lard oil or a mixture of 50% lard oil and kerosene.

Soluble oils and kerosene have the disadvantage of washing any oil from machine surfaces that require lubrication.

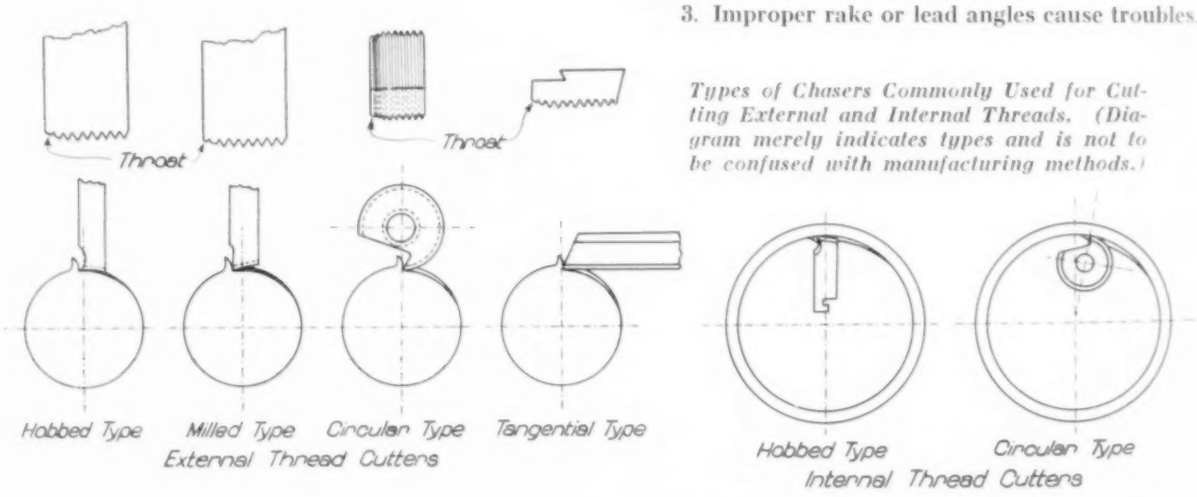
Common Threading Difficulties

A number of common threading difficulties and their correction may be listed:

1. Chasers may be too brittle or too low in hardness. For instance, chasers giving excellent results on butt welded pipe would prove to be too soft for good results on cast iron or Grades C and D seamless pipe.

2. Poor alignment of work being threaded in respect to chasers or poor mechanical alignment of machine parts may cause poor performance of chasers.

3. Improper rake or lead angles cause troubles.



Types of Chasers Commonly Used for Cutting External and Internal Threads. (Diagram merely indicates types and is not to be confused with manufacturing methods.)

4. Grinding cracks on resharpened chasers may be due to the use of emery wheels in the tool room that are too hard or dull, or cooling the tools in water after heavy grinding.

5. Some causes of chipping are (a) misalignment, (b) badly sheared stock, (c) hitting shoulders on close-to-shoulder work, (d) excessively hard grinding by dull or filled wheels causing minute grinding checks, (e) too high and in some cases too low a speed, (f) improper, insufficient or poorly directed coolant.

By Henry C. Bigge
Supt. Tool Steel Dept.
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Bethlehem, Pa.

Previous Installments in
"Toolsteels, Past and Present" are:
Historical Survey, Oct. 1937, p. 455
Crucible Melting, Dec. 1937, p. 773
Arc Furnace Melting, March 1938, p. 253
Induction Furnace Melting, May 1938, p. 489

forging and rolling Toolsteels

STEELS which are fragile and difficult to roll (such as high speed steels, 38% cobalt magnet steels, various compositions of high carbon, high chromium steels with 11.50 to 18.00% chromium, and high alloy steels with air hardening properties) are cast into specially designed square ingot molds with the big end up. Ingot sizes, designated by the top dimensions, range from 4½ to 13 in. square, and the weight from 80 to 2300 lb., including the hot top or sink head. The other grades of carbon and alloy toolsteels are cast into rectangular molds, 16×19 in. to 23×28 in. or into corrugated molds (16 to 30 in.). Ingots weigh from 2000 to 13,000 lb. and are press forged into blooms and billets, or rolled on a suitable blooming mill.

In considering the size of an ingot in relation to finished bar it is necessary to take into account both the internal structure of the ingot, and the amount of mechanical working, or reduction, which the ingot is to receive. This is expressed in percentage of reduction of cross-sectional area from ingot into finished bar. For instance, a 3-in. diameter bar (area 7.1 sq.in.) made from a 9-in. square ingot (area 81 sq.in.) is said to have undergone a reduction of 81—7.1 or 73.9 sq.in. which figures to 91.2% reduction on the original ingot size. Another way of expressing it is that it has an 11.4-to-1 reduction (81:7.1=11.4:1). As ingots and billets are worked mainly in the longitudinal direction, with very little spreading or upsetting, the percentage of reduction is a good index of the total amount of mechanical working.

Amount of Reduction Necessary

Good practice calls for a reduction of 90% or more from ingot to finished bar. This is readily obtainable in small bars because small ingots can be handled with comparative ease, but in case of special alloys (where approximately a 13-in. ingot is the maximum size obtainable), it is sometimes necessary to be content with smaller reduction, on account of the great difficulty of handling and forging larger ingots. With the larger sizes of finished bars it is necessary to obtain the benefits of hot working by resorting to upsetting operations. In any event the result is that only shorter lengths of bars are available.

Hammer cogging, or breakdown, the first step in the reduction of the ingot to a billet, generally involves sufficient hot deformation to reduce the ingot to about 50% of its original cross-section, with a corresponding doubling in length. Using high speed steels as an example, treatment preliminary to reduction will be outlined; while such treatment is intended primarily to keep the material in a sound physical condition, it may have a beneficial effect on the subsequent structure and the distribution of the carbide particles.

High speed ingots are inherently in a very sensitive condition, with columnar crystals extending at least part of the distance from the surface toward the center of the ingot. When not properly handled, these ingots are therefore highly susceptible to fracture. The low coherence is undoubtedly aggravated by the fact that not only carbides, but also impurities in the steel, have a tendency to precipitate at the grain boundaries.

Heating Schedules for High Speed Ingots

Ingot Size	Preheating Time	High Heat	Reheating*	Total Time	Resulting Billet
7½ in.	24 hr.	12 hr.	2 hr.	38 hr.	4 in.
9	28	16	4	48	4½
12	38	20	6	64	6
13	42	22	8	72	8

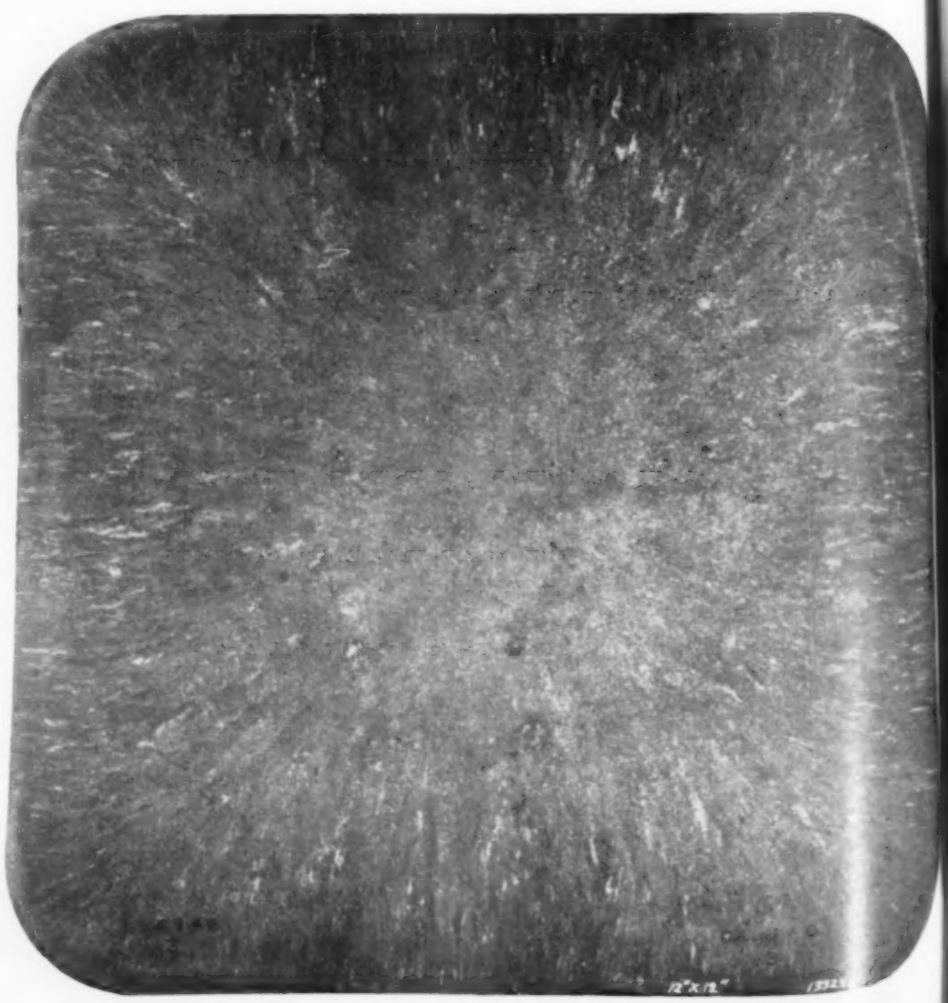
*Represents time in high heat furnace to restore temperature between forging operations.

To prepare high speed steel ingots for hammer cogging, the ingots remain in the molds until completely solidified. The time required depends upon the cross-section and weight of the ingot. Immediately upon stripping they should be charged hot into a suitable preheating furnace maintained at 1150 to 1200° F. Here they should be held for 12 to 24 hr., according to the size. They should then be transferred to a second preheating furnace, where they are held at 1600 to 1650° F. for 12 to 24 hr.

These thoroughly heated ingots should then be transferred to a properly designed heating furnace at 2150° F., equipped with an automatic gas analyzer for atmospheric control of the heating chamber in order to hold scale losses to a minimum. The time required for heating various sizes of square ingots is approximately as shown in the table above.

Ingots may be hammer cogged on a steam hammer of ample capacity; the first pass (series of impacts or blows) under the hammer is made at about 2150° F. When the ingot is uniformly heated to this temperature it is drawn from the furnace and placed on the anvil; it is then given a series of light impacts while moving it slowly along the dies, first on one face, then on the other, turning it 90°. This is then followed by "packing" the corners, hammering with a very light impact, while the ingot is tilted diagonally. The metal is in a fragile condition due to its crystal structure, as cast (shown in the photograph of structure of a 12-in. square ingot). Only when the steel has undergone some deformation, with resulting recrystallization during time at high temperature, can it withstand more severe hammering.

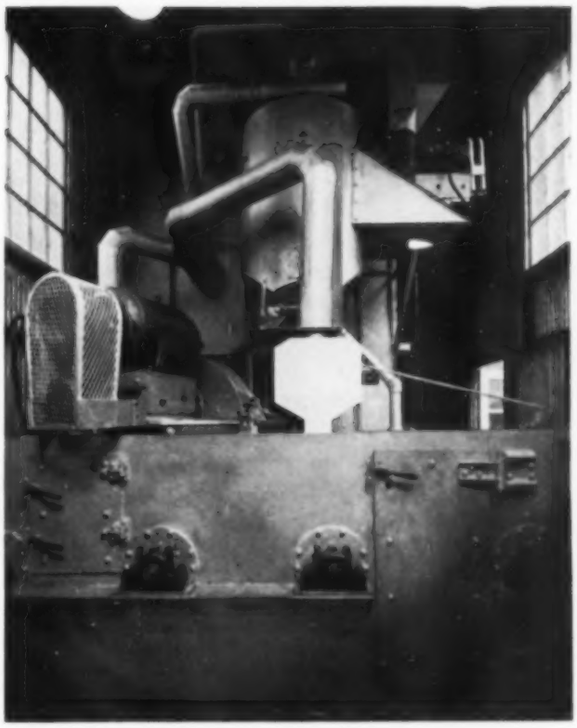
After the first light reduction, the ingot should be returned to the furnace and heated uniformly to approximately 2150° F. Time is approximately as shown in the table. It is then again withdrawn and reduced further, this time with slightly greater impact. When cooled to about 1800° F. with the corners to about 1700° F. the cogged billet is again returned to the heating furnace for another reheating to approximately 2150° F. It has now been worked sufficiently to withstand greater impact of the hammer without danger of rupture, that is, it has been refined, producing a structure with no sharp lines of



internal weakness (as shown in the photograph of the 6-in. hammered billet). Cogging can then be continued until the desired billet size has been obtained, provided the steel is within the hot working range.

One advantage in using the hammer for cogging is the easy removal of corner cracks, the most common defect encountered. Cracks naturally form across the corner lines where the metal has least support. These cracks are removed, as soon as they appear, by placing a steel gouge over the affected corner and striking it sharply with the hammer. Another advantage is that it is possible to attain a very low percentage of reduction by hammering. In rolling, on the other hand, whether box, gothic or special passes are used, the percentage of reduction in each pass is fixed. It is obvious therefore that to obtain the proper reduction for the various compositions, a very large number of roll sets would be required.

When it is desirable to use a rolling mill, in the first passes at least, the rolls must be designed for small and moderately increasing deformation. At some plants only the small ingots, say up to 4½ in. square, are cogged in the rolling mill using box passes while the larger sizes are always cogged on the hammer. This differentiation is advisable because high speed steel ingots become much more sensitive and fragile with increasing size. Compared with hammering, roll cogging has the further disadvantage that corner cracks, when formed, cannot be removed. Instead they are rolled down and flattened in succeeding passes and must later to be ground out in a separate operation,



An Excellent Method of Removing Scale From Billets Is to Blast Them From All Sides With Steel Shot While Passing on Roll Table Through a Protective Housing

which is a very costly procedure for deep cracks.

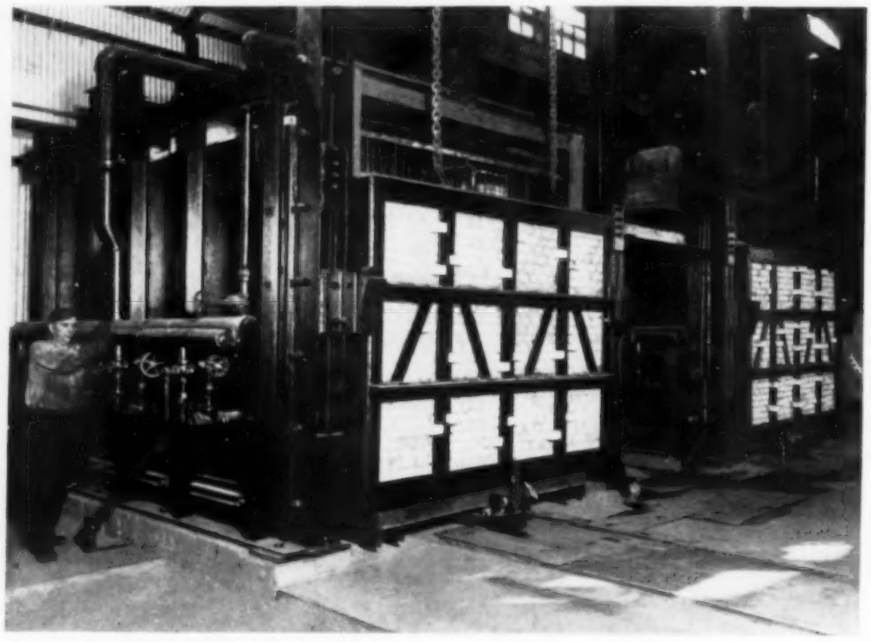
To prevent internal strains and ruptures caused by rapid cooling, the cogged or hammered billets may be buried in an insulating material until they have cooled to about 250° F. Another plan is to place the billets in a steel container, cover them with an insulating material and transfer to an annealing furnace. Here they are heated to 1600 to 1650° F., thoroughly soaked out and cooled in the furnace to 1000° F. The container is then removed from the furnace and the billets are taken out after they have further cooled to approximately 500° F. This softens the product to permit sawing or machining. A disc can thus be obtained from the billets representing the top and bottom of the ingot for an acid etch or macroscopic test which will reveal any internal defects. The above annealing operation also has the advantage of making the billets less susceptible to grinding cracks.

Slice Cut Across 12-In. Ingot of High Speed Steel and Pickled in Strong Acid Shows the Columnar Structure That Induces Cracking Unless Early Forging Is Most Carefully Done. Right-hand view is of 6-in. billet, after proper forging, and shows a good degree of grain refinement. Both reproduced at half size

Imperfections in the surface of the original ingot, as well as defects which may have been caused by heating and cogging, must be removed to prevent their appearance in the finished bar. If at this stage the billet has to undergo only one more heating for the finishing operation, a very careful inspection for surface seams is necessary. If more

than one reduction or conversion is to be given subsequently, it is necessary to remove only major defects at this stage.

A convenient and effective method of removing defects is to eliminate them by grinding with an abrasive wheel of correct grade and grit mounted on a swing frame, billet grinding machine. One advantage of this procedure is that the wheel grinds across the billet — hence across the seams, which practically always are longitudinal. Grinding across rather than with the seams shows them up more readily. It is advisable to grind lightly to avoid local over-



Very Deliberate Heating of Cold Toolsteel Ingots and Large Billets Is Conducted in These Two Preheaters, One Operating at 1200° F., the Other at 1650° F.

heating, which might in turn cause cracks.

Another advantage of slow cooling or annealing as described above is that it decreases the tendency of the billets to crack when they are heated for further working; prolonged preheating is therefore not required before they are charged into the finishing furnace. However, in any case the hearth of the heating furnace should not be above approximately 1000° F. when the billets are charged.

A recogging operation is required where the ingot cannot be reduced to the required billet size in one operation. High speed steels practically always require a finishing operation, apart from, and in addition to the cogging. As mentioned above, the major defects are removed after the first cogging operation. After the secondary cogging operation the billets should be cleaned of scale to reveal surface defects which are then ground out. (Shot blasting with steel shot is a very good way of descaling billets.) This careful inspection and surface grinding gives the best insurance against seams and surface imperfections in the final product.

Removal of surface defects is of fundamental importance in the manufacture of good hardened tools and toolsteels, as small surface seams and similar defects almost invariably lead to breakage or at least cracking in the hardening operation.

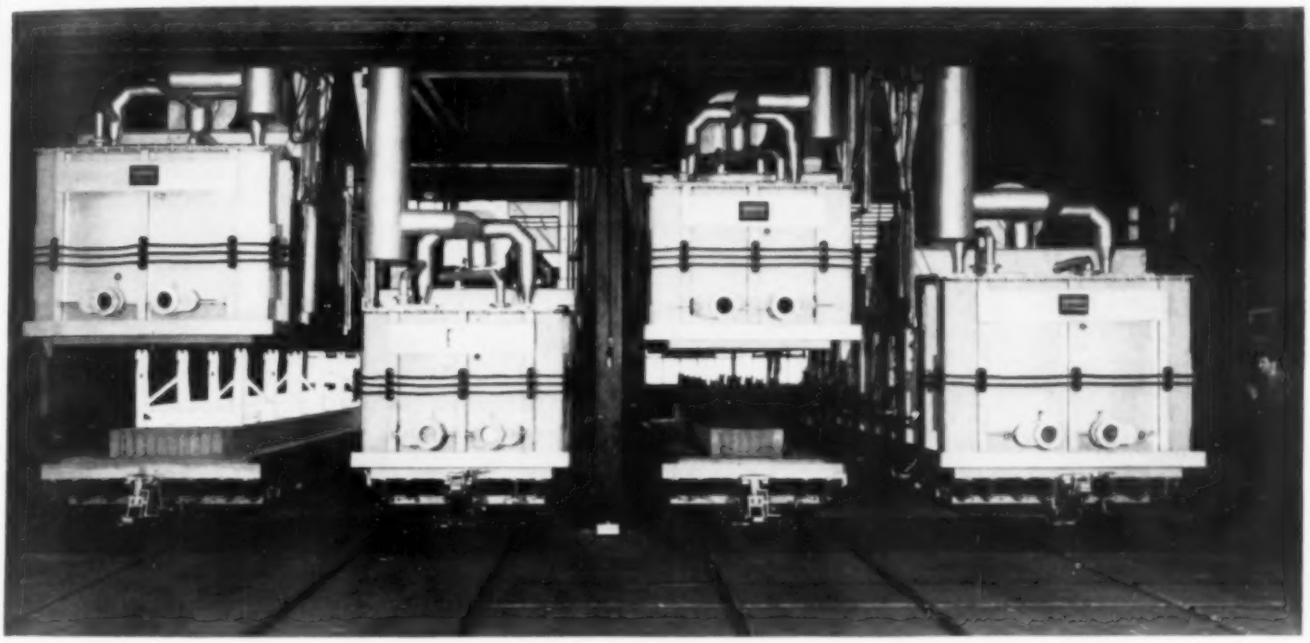
After the processing outlined, the billets are ready for the final forging or rolling to size. As they are in the annealed condition, the metal is able to adjust itself more readily to the stresses set up during heating prior to the final sizing operation. However, even annealed billets should be heated comparatively slowly. This is desirable for two reasons. First, due to the sensitivity of high speed steel and high alloy steels containing a large percentage of carbon, even when annealed, any sharp temperature difference between the inside and outside of the billet might still lead to internal rupture. Second, high speed steel should not be kept too long at rolling or forging temperature before working, as the material may decarburize, or crack or tear in the deformation. If the billet is placed directly in the high temperature zone of the furnace, the outside will be brought up to the forging or rolling temperature long before the inside, and shattering may occur when the plastic surface is rolled over the relatively unyielding core. This is particularly true for large billets, as for instance when recogging 4-in. square. Billets should therefore be heated slowly in a properly designed furnace with enough time for "soaking" to allow the

heat to penetrate thoroughly. It is customary to follow the rule "one inch per hour" in heating high speed steel, that is, the number of hours required is the same as the thickness of the billets in inches. A good heating schedule provides a maximum time at the lower temperature and minimum at the high or rolling temperature.

The proper atmosphere to use in heating high speed steels, whether slightly oxidizing or reducing, is a much debated question. In the writer's opinion it is desirable to use a very smoky flame. A sharp or strongly oxidizing flame has an injurious effect on this type of steel, tending to tear or crack on the first deformation, thereby causing surface defects ruining the steel for the manufacture of tools.

Heated slowly and carefully in a flame laden with hydrocarbons, the billets should be brought to a temperature of about 2150° F. They are then ready for final forging or rolling. Billets should be withdrawn from the furnace and rolled as soon as this temperature is reached and they are properly heated throughout the cross-section, as prolonged heating at this point leads to weakness and tearing. Tearing also occurs as a result of too high a temperature. If rolled in rolling mills using gothic passes it practically always manifests itself at the corners of the billet in the first couple of passes, because the corners are naturally most readily overheated, secondly, because the metal at the corners is least supported, and thirdly, because the greatest stress in tension is applied to the horizontal pair of corners.

To prevent internal ruptures after rolling, the finished bars should be placed in heated retorts or in steel boxes and covered with an insulating material to insure slow cooling. As most users of high speed steels machine their tools from the purchased bars it is customary to anneal practically all such bars. Annealed bars are also more easily inspected, cut and straightened. (Before annealing, the bars are shot blasted to remove any iron oxide formed on the surface during the operations of heating and finishing forging or rolling; the removal of this oxide reduces the tendency to decarburize during the annealing operation.) They can be packed tightly without any compound, in steel pipes sealed at one end. A cover containing a charcoal cartridge should be slipped over the charging end of the annealing pipe and the space between the pipe and cartridge should be sealed with fire clay. The charcoal combines with the oxygen present in the pipe and in the air entering during cooling and holds down the



Battery of Electrically Heated Annealing Furnaces for Toolsteels. Car bottoms with racks and stanchions facilitate loading. Self contained heating covers carry fans for circulating atmosphere during heating or cooling cycles

oxidation or decarburization on the surface of the bars.

The annealing pipes may be placed in an electrically heated furnace so built to insure uniform and accurate temperature control. If an oil-fired or gas-fired furnace is used it should be designed and operated so that the atmosphere in the furnace approaches that of an electric furnace; a car bottom design facilitates loading and unloading. The annealing cycle is determined by the composition of the steel, its weight and its distribution in the furnace. As an example, a 10,000-lb. charge of standard 18-4-1 high speed steel bars, packed in 12-in. diameter pipes should require 8 hr. for heating up to 1650° F., the charge should be held at this temperature for another 8 hr. and then cooled down to 1200° F. at the rate of 20° per hr. The pipes are withdrawn from the furnace at 600° F. as the rate of cooling below this temperature has practically no effect on the hardness. However, the bars remain in the pipes until they are near room temperature, for convenience in handling.

The above annealing practice applies to high speed steel. Carbon and alloy toolsteel bars, on the other hand, are usually packed as tightly as convenient in steel boxes with a tight fitting cover, or in steel pipes with one end sealed. The other end of such a pipe is used for charging the bars and packing compound; it is then closed by slipping on a steel cover and sealing the joints with fireclay. A useful packing material consists of three parts of finely sifted dry ashes to one part of crushed coke, charcoal, petroleum coke or partly burned coal. Cast iron chips are also good packing material. Such chips fill the voids as well as do ashes, charcoal or coke and are therefore equally effective in reducing the volume of air drawn in during cooling. Expansion of the air in heating causes the clay seal to crack which permits air to enter during the cooling of the charge, thus causing oxidation and decarburization of the surface of the bars. Charcoal and similar reducing agents combine with the oxygen in the air sucked in, but as the temperature drops the carbonaceous packing material ceases to react at a point where steel is still susceptible to oxidation. Bars annealed with charcoal therefore have a thin scale, visible as temper colors, at least at the ends where the air enters. Cast iron chips, on the other hand, are oxidized as readily as steel itself at the lower temperature. They will therefore combine with most of the oxygen, leaving the bars a dull gray.

Magnesium-Aluminum Alloys

in aircraft construction

By R. le Coeuvre

Abstract of Paper (With Discussion) Before Royal Aeronautical Society, *The Metal Industry*, Nov. 4, 1938, p. 437

SINCE the light alloys in aircraft construction are meeting competition from other metals and non-metals (plywood, plastics, stainless steels, heat treated alloy steels, monel metal) which are the objects of constant research and improvement, it is probable they will keep their present superiority by virtue of continual evolution to meet the needs of the day. Important steps in this direction on the Continent — especially in Germany — are the advent of wrought aluminum alloys containing several per cent of magnesium, used in the fully annealed condition. (Magnesium enters solid solution in aluminum up to 15.3% at 845° F.; the solid solubility decreases with temperature, being about 3% at 70° F. Binary alloys containing considerable magnesium can therefore readily be homogenized by annealing at 800° F. and cooling quickly; mild reheating of alloys containing say 6% or more magnesium will cause incipient precipitation of the beta phase, Al_3Mg_2, which reduces ductility — among other effects.)

Broadly, these alloys have two very important advantages: (1) They are weldable into joints of high strength; (2) they are non-corrodible by sea water, at least in the unstressed condition.

Alloys containing less than 7% of magnesium have ultimate tensile stress of 45,000 to 52,000 psi., and 25% elongation. These properties are obtained after annealing. Forming, bending, and drawing are done cold on annealed metal and the metal is amenable to deep drawing without damage. The metal may also be worked hot, since its properties are not in any way due to quenching and, as soon as the metal cools to the surrounding temperature, the original properties of the annealed metal return. Autogenous welding requires an appropriate flux, every trace of which must be removed; otherwise there is risk of corrosion.

Alloys containing 7 to 9% of magnesium have tensile properties resembling those of duralumin. The ultimate tensile stress is of the order of 60,000 psi. and elongation about 25%, obtained by both heat treatment and quenching from a temperature of about 850° F. Between 300 and 650° F. the metal becomes brittle. This is a serious inconvenience, because the constructor may want to heat the material to just such a temperature in order to bake certain enamels or varnishes. Forging and drawing operations may be done *(Continued on page 706)*

By J. K. Findley
Allegheny Ludlum Steel Corp
Dunkirk, N. Y

Strand Annealing of stainless wire

THE PROCESS for producing wire from hot-rolled rod is essentially the same regardless of the metal or alloy used. This process is to anneal or heat treat the rod, then draw it cold through successively smaller dies until the desired diameter wire is reached, or until the physical characteristics of the wire are such that it is necessary to re-anneal before proceeding further with the reduction in size. In the making of finer sizes of wire this cold drawing and annealing cycle usually has to be repeated several times, depending upon the application for which wire of specified properties is to be used.

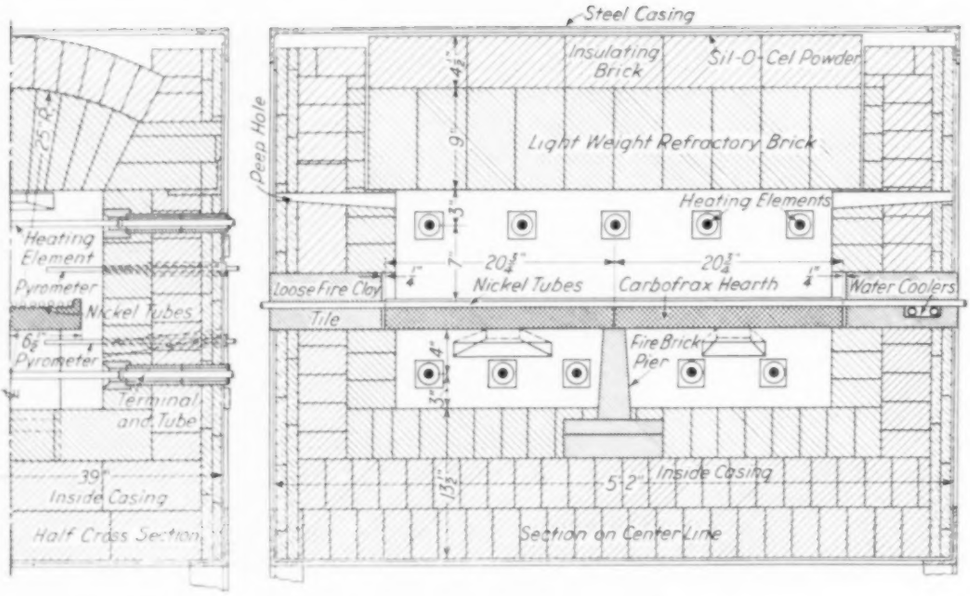
Large uses for stainless steel wire have been in screens and wire cloth for the paper and chemical industries, wire rope and cord for yacht rigging, control cords on marine planes or airplanes operated near saltwater, nails, screws, cotter pins, bolts and rivets subjected to relatively high temperatures or corrosive atmospheres, armature binding wire, welding rod, orthodontal wire, metal sponge wire, ornamental chain and braiding, wire stitches in cardboard caps for milk bottles.

High Temperatures Essential

Most stainless rope wire and spring wire made at the Dunkirk plant is of the 18% chromium, 8% nickel analysis and the necessary physical characteristics are obtained by cold drawing after annealing. Rapid cooling from a very high temperature is necessary to insure maximum corrosion resistance in some media. The desired properties of the finished wire determine the amount of cold drawing necessary after annealing; it is well known that austenitic alloys like 18-8 harden (strengthen) readily upon cold work. The greater percentage of wire for weaving purposes is also 18-8 or 18-8 with a molybdenum addition. This wire is given a final anneal in strand furnaces with a prepared atmosphere for bright annealing. Wire of the above analysis for cold heading (as for bolts and fasteners) is usually given a light draft after the last anneal, to gain proper temper and to draw a lubricating coating into the surface. Straight chromium types for cold heading are also given a light draft after annealing. Stainless sponge wire made of what we call "Ludlum RA metal" is given a heavy cold draft after a thorough bright anneal.

There are two general methods of heat treating or annealing wire; namely, batch and strand. In the batch method whole coils, bundles, or spools of wire are placed in the furnace, whereas in the strand method single strands of wire move continuously through heated tubes.

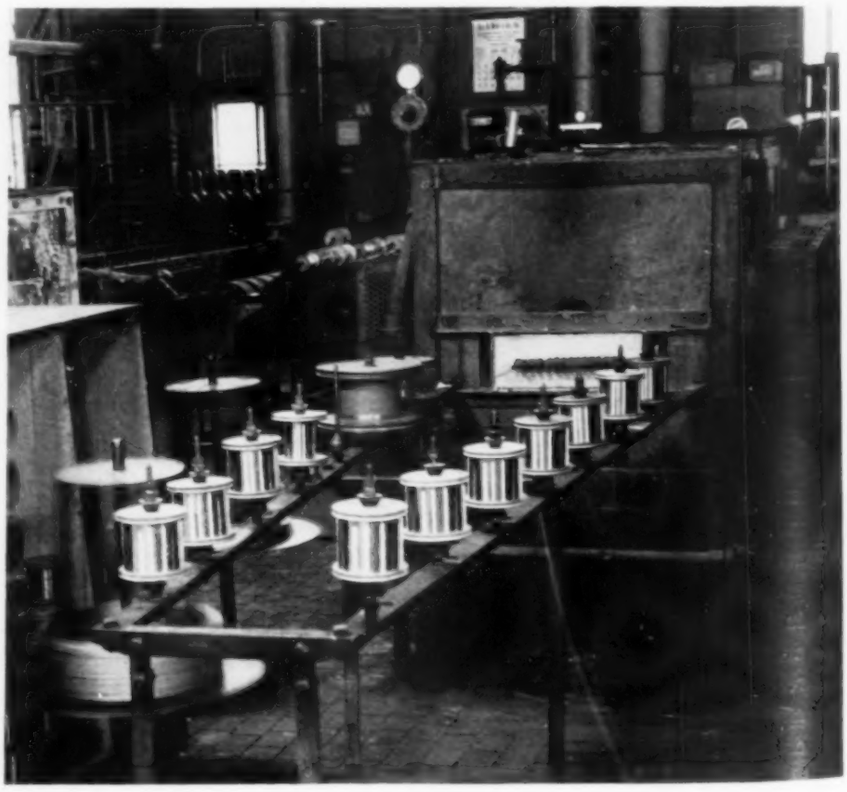
In the production of stainless wire, either method of annealing has been employed on the hot rolled rods prior to drawing or for the process anneals required on the larger wire sizes. In such operations either method can obtain very uniform structure without excessive scaling to any portion of the coils. As the size of the wire to be annealed decreases, the advantages of strand annealing increase, especially when an atmosphere is kept around



General Drawing of Continuous Wire Annealing Furnace Equipped by Globar Corp. Electrical control by tap changing transformers allows voltage to be varied between 60 and 200 by 10-volt steps

the heated wire to prevent any oxidation. This is due to the fact that chemical reactions at the surface of hot metal take time, and effects that may not be noticeable in a short strand anneal will be very evident after a liesurely batch anneal, even in the same atmosphere and at the same temperature. Normal weight coils of stainless wire approximately $\frac{3}{32}$ in. diameter and smaller have such a cross section that the surface of the wire becomes quite oxidized due to the length of time necessary to hold the coils in the batch annealing furnace to insure uniform temperature throughout the mass of the coils. After pickling to remove this scale, the wire is from 0.001 to 0.002 in. smaller in diameter than before annealing. On sizes over $\frac{3}{32}$ in. it is questionable whether this loss of metal is sufficient to warrant the cost of strand annealing equipment using a non-oxidizing atmosphere; however, on sizes much smaller than this the loss of metal is great enough to make strand annealing through a non-oxidizing or bright annealing furnace an economical operation. To the date of writing, successful bright annealing of stainless wire in batches has not been announced.

Another advantage of annealing bright is that the surface condition of the wire seems to be better for redrawing than if the wire had been pickled to remove scale after annealing. Of course, on the fine sizes of wire where both high luster finish and dead softness are necessary there is no alternative but to bright strand anneal through a non-oxidizing furnace.



Entrance End of Furnace, Electrically Heated to 2200° F., for Strand Annealing of Stainless Steel at High Speed in Hydrogen Atmosphere. Three different sizes of wire are being drawn through the furnace at appropriate speeds (a) from small spools, (b) from larger reel and (c) from coils one of which is shown in left corner

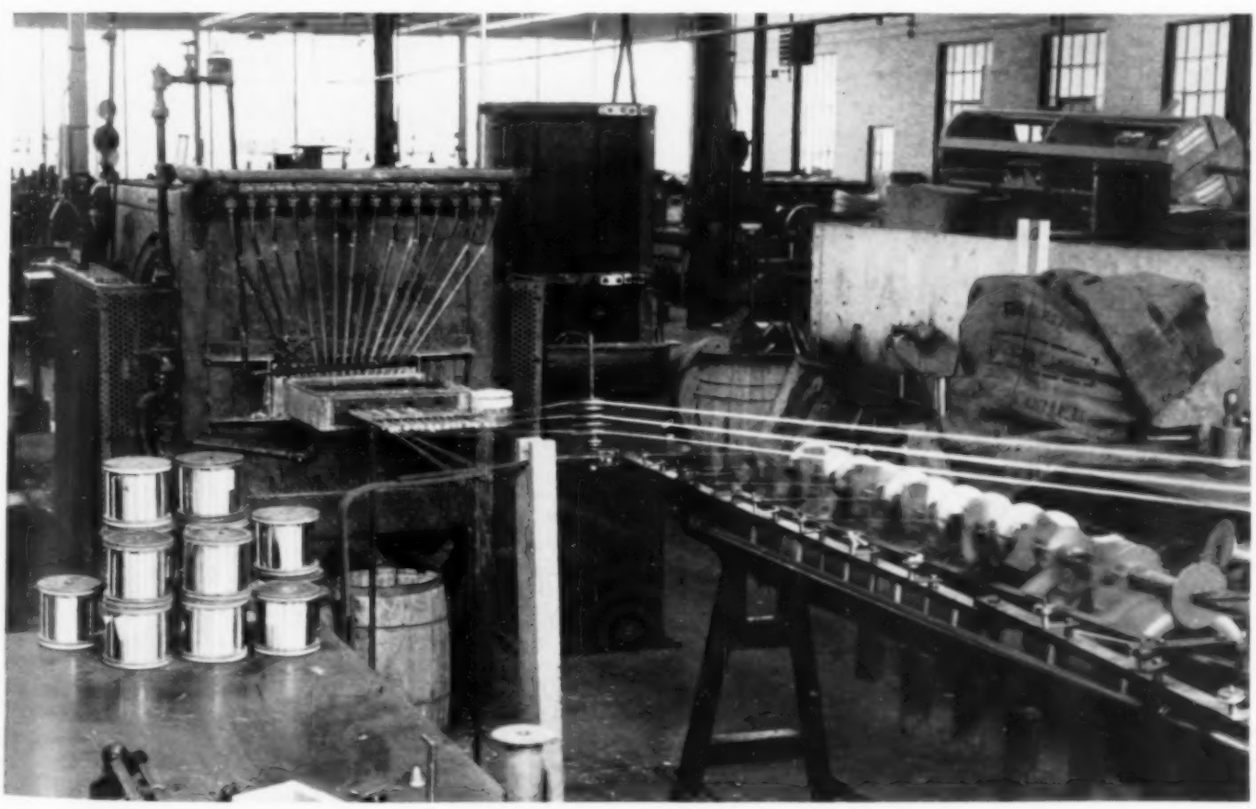
At the Dunkirk wire mill of the Allegheny Ludlum Steel Corp. bright strand annealing of the sizes of stainless wire in process under 0.100 in. diameter has largely replaced batch annealing. Most of the stainless wire produced in the fine wire department, which finishes in sizes between 0.100 and 0.003 in. diameter, is of the austenitic type which requires high annealing temperatures.

In the bright strand annealing of these austenitic types we have found that a comparatively short zone, heated to 2200 to 2250° F., gives the desired structure and physical properties. The wire is moved through the tubes in the furnace at such a rate as to assure its reaching 1900° or 2000° F. It has been determined that as much wire of any given size can be put through per minute in a furnace heated to 2250° F. as can be put through a furnace three times as long but heated only to 2200° F. Fine wire is handled at speeds as high as 200 ft. per min.

Two electrically heated, bright strand annealing furnaces designed with a short, high temperature heating zone as described above were recently constructed and put in operation at the Dunkirk plant. These furnaces were made possible by the use of non-metallic heating units of silicon carbide. They have a uniform heating zone 13 in. wide by 40 in. long, with half the heating units mounted above the hearth and the other half below the carbofrax hearth. Nickel tubes, ½ or ¾-in outside diameter, are placed on the hearth and a hydrogen atmosphere is maintained within them. Cylinder hydrogen is purified of traces of carbon oxides by passing through a tower filled with potassium hydrate, of oxygen by passing over hot copper turnings, and of moisture by refrigeration. The nickel tubes have a minimum life of six months.

As shown in the accompanying views the wire is run off of reels or spools through these hot tubes, then through a watercooled jacket at the exit end of the furnace to insure rapid cooling, and immediately spooled or reeled automatically, ready for redrawing or shipment as the case may be. These furnaces have performed with entire satisfaction and have materially decreased the cost of this operation.

Exit End of 14-Strand Furnace, Showing Water-Cooled Prolongations of Tubes and Connections for Hydrogen Atmosphere. Note bright finish of annealed wire on table. Unique spooling equipment insures uniform speed through furnace despite amount of wire wound on spool by resting the latter on one of a series of rotating drums from which it is driven by friction



EMANVEL SWEDENBORG,
Sacra Regia Majestatis
Regnique Suecia Collegii
Metallica Assessor.
Friedericus Hakel. Dedicavit.
Pictor. Norrk. ad viv. delin. Dresdae.
Bernigroth fil. sc. Lips.

EMANUEL SWEDENBORG

Commissioner of his Royal Majesty's and the Swedish Kingdom's Department of Mines

(and a pioneer metallurgist)

A trenchant comment upon the swift progress of metallurgical science is provided by the 250th anniversary of the birth of Emanuel Swedenborg, author of the first textbooks on the metallurgy of iron and copper.

Third child of Jesper Svedberg, Rector of the University of Upsala, Court Chaplain, and Superintendent of the Swedish Churches in America, young Emanuel was assured a good education. He took a degree at Upsala at the age of 21, then spent five years studying and working in England, Holland, France and Germany. Returning home, he founded and edited the first Swedish technical journal, *Daedalus Hyperboreus*, which associated him with Polhem, a physicist and mechanician who became chief adviser to Charles XII. Through this friendship Svedberg was appointed at the age of 28 assessor (commissioner) in the College of Mines, a government department which had administrative jurisdiction over the whole mining industry of the Kingdom and its labor relations, as well as judicial authority in all lawsuits involving mining interests.

This post was far from a sinecure. For the next 30 years Svedberg spent the winter months at sessions of the College in Stockholm, and the summer in tours of inspection that resulted in thorough studies of metal works in Sweden (where iron and copper mining and smelting was the principal industry), Saxony, Bohemia, Austria and Flanders. The College met daily, the roll was called, and a record kept of the proceedings and of the technical reports received. This mass of material, still preserved, is an ample source of information about mining and smelting as practiced then, and concerning the middle period of Swedenborg's life (for the Svedberg family had been ennobled and assumed the better-known variant of the name).

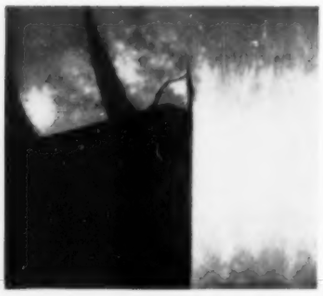
Swedenborg inherited some iron works, and his interest was therefore personal as well as professional. His travels abroad, and his observations on the widespread utilization of Swedish pig iron as raw material for foreign manufacture of wrought iron and steel in German or Walloon hearths, had convinced him that his countrymen would do well to multiply their forges and export refined iron and steel rather than pig iron. When he attempted to explain the refining, or rather conversion, process, he was at a great disadvantage (in comparison with his detailed knowledge about blast furnace practice — substantially what it is now) for he lacked any theoretical foundation upon which to appraise his observations of numberless curious details of Continental practice, even though Réaumur's classical book "On the Art of Converting Iron to Steel" had been published in 1722 and Swedenborg refers to it in his books printed 12 years later. The various smiths guarded the essential operations as most valuable trade secrets, and were adept at confusing and meaningless rigmaroles. Each master workman had his own measuring stick with secret marks for dimensions of hearth and slant of the tuyere, and in order that a thief could not steal this information in an unguarded hour, he would break down the walls every Saturday and rebuild them on the following Monday.

The books on the metallurgy of iron and copper are volumes II and III respectively of what was intended to be a more comprehensive series to include the noble metals, more interesting to the cognoscente then as now. Volume I was a treatise on physics, and the three appeared simultaneously in Dresden and Leipzig in 1734 under the title "Opera Philosophica et Mineralia". Written in Latin, the universal scientific language of the day, they are closed books to nearly all technologists now. They enjoyed wide circulation at the time, and exerted considerable influence on the development of the metallurgical industries — more so on the Continent and in England than in the author's native land. Today they are a definite record of the art two centuries ago. Volume I ("Principia") is available in an English translation, as is now volume III ("de Cupro" — a review of which is printed on page 691). Volume II ("de Ferro") was translated into French soon after publication; in 1926 a Swedish translation by H. Sjögren appeared under imprint of Wahlström and Widstrand, Stockholm, worthy to rank with the Hoovers' translation of Agricola in its technical accuracy and typographical excellence.

Swedenborg's attention was drawn to physiology toward the middle of his life, and eventually to religion. His writings after he had reached the age of 60 years on the relation of the body to the spirit led to his renown as a great mystic, wholly overshadowing his eminence as a natural philosopher in a time when alchemy was giving way to experimental science. Where Swedenborg stood in this conflict was very evident in his works, which were based on facts and observations rather than speculations, thus bearing out the statement in his preface, "I have touched very lightly upon the figments of the alchemists, and have hardly wished to taste them, except with the tip of the tongue, lest weeds bring harm to the promising harvest."

Chip Formation
photographed with high speed camera

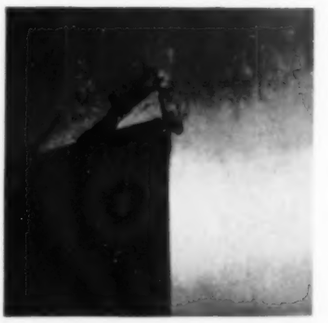
by Research & Development Division
Jones & Laughlin Steel Corp.



IN THESE FRAMES only the extreme tip of tool is shown at lower left. The chip itself forms the fragmented gray material in the upper left corner. The top frame at left shows the tool tip in direct contact with the bar, and the other ones show a deposit of chip material clinging to the leading edge of the tool. The wedge-shaped cutting edge over which the subsequent segments flow is quite visible. This wedge is not a permanent formation and under certain circumstances does not exist at all. These pictures were taken at a speed of 800 frames per sec., and the five show what took place when a ¾-in. cold-drawn bar of bessemer screw stock moved 0.085 in. past a lathe tool.

Top frame at right shows an already formed built-up edge at the tip of the tool and illustrates its protective position over the tool edge, also how it acts as a cutting medium. The rest of the frames show the start of a new chip coming down over the built-up edge and forcing the already formed chip segment away from the tool face.

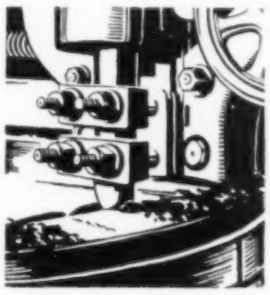
It should be emphasized that these views represent only one type of cutting action, there being at least three basic types (according to Hans Ernst in the new ASM book on "Machining of Metals").



Function of Cutting Fluids

IN A RECENT ADDRESS on the above subject before the British Institute of Petroleum (quoted in *The Engineer*, Oct. 21, 1938, page 441) Prof. H. W. Swift said that cutting fluids have a dual function, to lubricate the passage of the chip along the tool face but primarily to cool the tool. Cooling can be effected either by prevention or

cure, the frictional heat passing to the tool can be reduced by lubrication, or the temperature rise due to the heat generated can be reduced by the cooling action of a circulating fluid. In principle, prevention is better than cure, and effective lubrication would not only reduce the temperature of the tool and the stock (minimizing distortion), but would also reduce the power required for cutting and promote continuity of chip formation and so improve the work.



On the other hand, under the drastic conditions imposed by cutting, efficient lubrication is much more difficult to achieve than efficient cooling, and except with light cuts and low speeds (where the failure of lubrication would have no serious consequences) there is greater safety in a coolant than in a lubricant. There is, of course, greater virtue still when the two functions can be combined in a single fluid. A fluid which provides efficient lubrication and cooling will not only perform the essential functions of increasing tool life and performance; it will also reduce power consumption, prevent distortion of the work, improve accuracy and finish, and will also help to remove chips where necessary.

In order that a cutting fluid shall be effective it must be applied in the proper quantity and in the right way. Generally it is considered that an ample flow at a moderate velocity provides the most efficient cooling action. In some cases where the fluid is relied on to remove the chip (as in deep drilling) a high velocity is advantageous.

There are also certain places where the volume of coolant may properly be restricted. Apart from those metals and operations for which the use of a cutting fluid is unnecessary, there are conditions under which efficient cooling may prove a disadvantage. A cutting emulsion may reduce the life of a tool when taking fine cuts on carbon steel, owing to its quenching (hardening) action on the heated surface, and it has been suggested that too efficient cooling may restrain the flow of surface molecules necessary to produce a high finish. It has also been found that the life of a high speed tool increases as its temperature is raised up to a certain point. Hence a coolant is inadvisable under conditions which do not heat the tool above its optimum temperature.

The cutting fluid should, of course, be applied as close as possible to the point where the cooling action is required, and it has long been the general practice with lathes to apply the fluid to the chip at the point of its removal from the stock. There is direct experimental evidence in favor of directing the fluid from the rear of the tool up into the clearance angle between tool and receding stock. Up to a certain point two streams, one from above and one from below the tool, have a cumulative effect.

In editorial comment in the same issue of *The Engineer* it was suggested that the chemical action of a cutting fluid is a possibility that should not be ignored for the temperatures at the root of the shaving are quite high and at the instant of severance the severed surfaces are in a nascent, or chemically very active, condition.

"Turning from speculative theory to practice, we have to note that the addition of flowers of sulphur to cutting oils or fluids has a well-known and very marked effect on the performance of a cutting tool. No explanation of the effect of sulphur in this respect can be wholly satisfactory if it ignores the possibility of chemical action between the sulphur and the metal being cut.

"Again, the addition of colloidal graphite to a cutting fluid is also well known to increase considerably the cutting efficiency of a tool. Graphite is known to possess lubricating properties and it is possible that some of its value when incorporated in a cutting fluid turns upon its ability to preserve its lubricating qualities at the high temperatures generated during cutting. On the other hand, some support for the suggestion that chemical action may play a part in the cutting of metals in the presence of a fluid may be derived from the fact that the chemical activity of most substances is greatly enhanced by reducing them to the colloidal form."

Professor Swift's conclusions are (1) heat of chip deformation and the frictional heat are of the same order, but the tool is heated mainly by friction; (2) a slightly sulphurized oil has better anti-frictional properties than other fluids studied; (3) aqueous solutions are better heat dissipators than oils are; (4) while conditions vary so widely that there can be no all-purpose oil, an emulsion with sulphonated oil base, would have very wide applicability, provided it were stable and non-tarnishing.

By Wilbur E. Sanders
Plant Engineer
and J. L. Coyle
Research Engineer
Chevrolet-Muncie Div., General Motors Corp.
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Continental Industrial Engineers, Inc.

a practical muffleless Carburizing Furnace

THE ART of hardening steel has developed gradually from early crude methods of packing in carbonaceous compounds and slowly heating and cooling the mass, up to the modern plan which eliminates extraneous solid materials and controls the chemical composition and metallurgical characteristics of the steel's surface by the thermal and atmospheric conditions. With each successive improvement in the art, manufacturing requirements have become successively more exacting until today the purchaser's specifications for carburizing and heat treating equipment require almost absolute perfection.

This article describes one of the latest commercial developments in this field, installed at the Muncie (Ind.) plant of the Chevrolet Motor Co. It is treating a wide range of carbon steel and alloy steel parts such as S.A.E. 4815-A, prominent among which are gears and auxiliaries for transmissions.

As is well known, carburizing is a method of producing a hard, wear resisting surface on a part cut from a softer, easily machined steel. Some of the important requirements of a commercial installation for doing this kind of work may be summarized briefly:

Cleanliness — It is impractical to assemble working parts that are not absolutely clean. Conventional carburizing and heat treating methods, particularly when substantial amounts of carbon are diffused into the surface of the article, usually leave the product with a layer of carbon or strongly adhering carbon scale. This has always been difficult and costly to remove. One prime advantage of this modern carburizing equipment is to deliver a thoroughly clean article ready for the assembly line without further operations.

Uniformity — Modern inspection methods eliminate any process or equipment that does not give an extremely high degree of uniformity. A variation of plus or minus two numbers on the Rockwell C scale is an allowable standard which present equipment makes possible. It is also desirable to maintain the depth of case to within plus or minus 0.003 in. and the relative amounts of hyper-eutectoid, eutectoid and hypo-eutectoid must be constant in order to deliver an acceptable product.

Controllability — Obviously any commercial device must be capable of ready control so that the character of the final product may be modified at will, and, when modified, will remain constant.

Freedom From Distortion — While carburizing itself does not ordinarily tend to cause distortion, subsequent heat treating (particularly quenching) may warp or twist the finished article. It is possible to eliminate most of this difficulty in the care and design of the heat treating equipment.

Operating Costs — It is, of course, obvious that the equipment must give desired results at a minimum of operating cost and a low fixed investment. Operating costs include, as major items, labor, maintenance and fuel.

Turning now to the new equipment installed at the Chevrolet plant to achieve these improved results, it consists of a "muffleless" carburizing furnace designed and manufactured by Conti-

neered Industrial Engineers, Inc. Its general arrangement is indicated in the diagram on page 680. It should be emphasized that the various units are connected with an air-tight union so that the articles being treated are not exposed to the air from the time they enter the loading vestibule at the entrance of the carburizing furnace until they are discharged from the draw furnace.

In order to handle a variety of parts it was desirable to move the material through the cycle on a series of light, grid type trays. One of these trays is shown leaning against a building column in the halftone below. It will be noted that they are extremely open for free flow of circulating furnace atmospheres and a free path for the quenching liquid when the tray, with its load, is lowered into the quench tank.

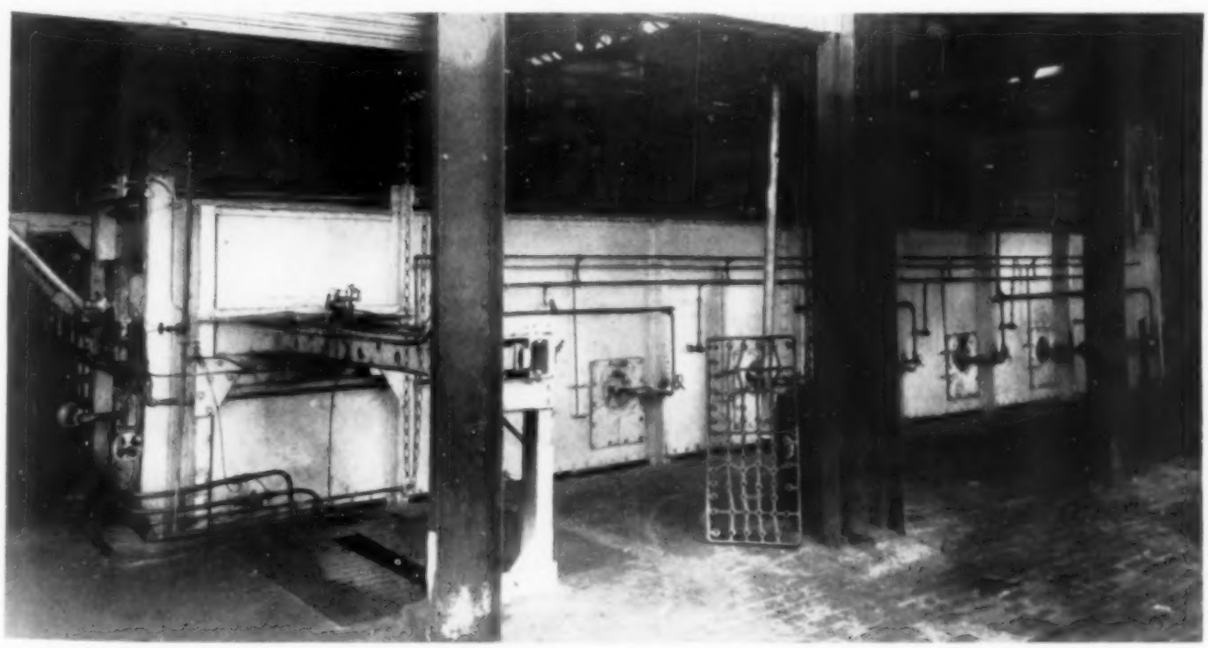
These trays with their load serve as the unit which is automatically moved through the complete cycle. The cycle is exactly controlled by an electrically operated timer, readily set to any desired time interval. The trays are moved by a series of cylinders; the motive power is oil at a pressure of 500 psi. All cylinders are operated by mechanically controlled oil valves and a system of interlocked pilot valves so arranged that no operation can take place until the preceding operation has been completed. This system, together with the interlocking limit switches, provides a foolproof arrangement which eliminates jams and interferences.

Enroute the trays are supported on alloy rails resting on refractory piers. Rails are supported on sockets in each pier and provided with expansion at each socket. A careful study of alloy composition has been made and the rails selected show little effect of the accumulation of carbon from the highly carburizing atmosphere. Ample provision for sag and creep has been made.

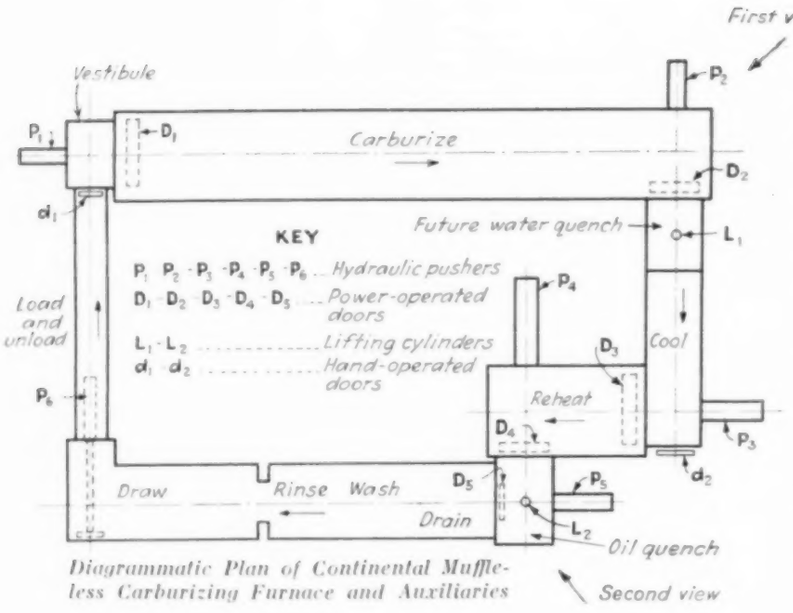
Each tray carries a useful load of 250 to 350 lb. of gears and other parts. The timing of the trays may be varied as mentioned above, but ordinarily about three trays per hour are put through the cycle, giving a total hourly net production ranging from 750 to 1050 lb. When treating standard parts made from S.A.E. 4815-A steel the average times and temperatures range about as follows:

Operation	Time	Temperature
Heating and carburizing	7 hr.	1525 to 1690° F.
Cooling	80 min.	600° F.
Reheating	80 min.	1460° F.
Quenching	20 min.	120° F.
Washing and rinsing	80 min.	160° F.
Drawing	80 min.	350° F.

As can be seen from the accompanying halftones, the entire furnace structure is ruggedly built of steel, thoroughly reinforced and of



Exceptionally Clean and Simple Construction of Carburizing Zone of Heat Treatment Machine Installed at Chevrolet-Muncie Division (General Motors Corp.). Gas-fired heating units may be sealed in event of trouble and readily replaced during week-end without cooling the structure



Diagrammatic Plan of Continental Muffleless Carburizing Furnace and Auxiliaries

welded construction, air tight and capable of withstanding necessary internal pressure. All vestibules are formed integrally with the furnace units and provided with automatically operated doors arranged to prevent the outward leakage of furnace atmosphere or the inward leakage of air.

Furnace walls are 13½ in. of special iron-free refractories backed by 4½ in. of heat resisting block, thus providing a graded insulated wall practically unaffected by temperature and carburizing gases. Considerable investigation was necessary to determine the proper type of refractories suitable for this purpose and a further investigation was necessary to determine a satisfactory wash for coating the interior.

Since there is no muffle in this furnace, yet it is heated with a gas flame, the flame and products of combustion must be prevented from mixing with the carburizing atmosphere. This is done by providing the furnace with a series of Continental combustion chambers of high alloy located beneath the rails and arranged along each side of the furnace in a staggered position. Each of these combustion chambers makes connection through a flexible seal with a down-comer flue leading the products of combustion to a flue beneath the furnace. (Some of the waste heat is utilized in the subsequent stages, as will be noted later.) This construction is very simple; it is possible to shut off any single combustion chamber at will and to remove and replace it without entering the furnace. In older types of carburizing furnace, a muffle repair involved a major reconstruction operation on the furnace and a long interruption to normal production. In direct contrast to this it is possible to continue operations in this furnace even in case of failure of a combustion chamber merely by shutting off this unit, and it may readily be replaced over any week-end without loss of productive hours. Stocking spare combustion chambers represents a minor investment in comparison with a complete muffle.

The furnace at the Chevrolet plant in Muncie uses natural gas both for fuel and carburizing atmosphere. Fuel gas is handled through single-valve, high pressure inspirating burners of the sealed-in type, one burner for each combustion chamber. The burners are divided into three groups for automatic control. Each zone is provided with a recording controller so that a record is maintained of temperatures in all parts of the furnace at all times. The first halftone (page 679) shows a side view of the carburizing zone with its arrangement of burners and piping. It is interesting to note the extreme simplicity; pipelines shown include those carrying oil for operation of the cylinders, atmosphere gas and combustion gas.

Convection Currents Effective

Since the combustion chambers are located beneath the load, the lower portion of the furnace block is maintained at a substantially higher temperature than the upper portion, thus causing a thermal circulation of the furnace atmosphere which contributes toward quick heating and uniformly carburized work.

Provision is made for introducing furnace atmosphere (raw natural gas) both above and below the work being carburized in readily controllable quantities. The proper distribution and control of furnace atmosphere is one of the important contributions of this furnace to the art of carburizing.

At the discharge end of the carburizing furnace the trays are automatically pushed sidewise into a slow cooling zone where the temperature of the entire load is dropped to 600° F. This portion of the structure, which is a light, air-tight metal shell connecting the carburizing furnace with the reheat furnace, is provided with a totally enclosed quench tank equipped

with hydraulic lifters and automatic interlocks so materials may be water quenched quickly, if desired, immediately at the end of the carburizing furnace and without intermediate cooling. During routine treatment of oil quenching carburizing steels, this equipment is not employed, but is very useful for certain less expensive alloy steels which offer attractive opportunities for increased production at lower cost. Such water quenched tray-loads may be removed at the end of the cooling zone without any further handling.

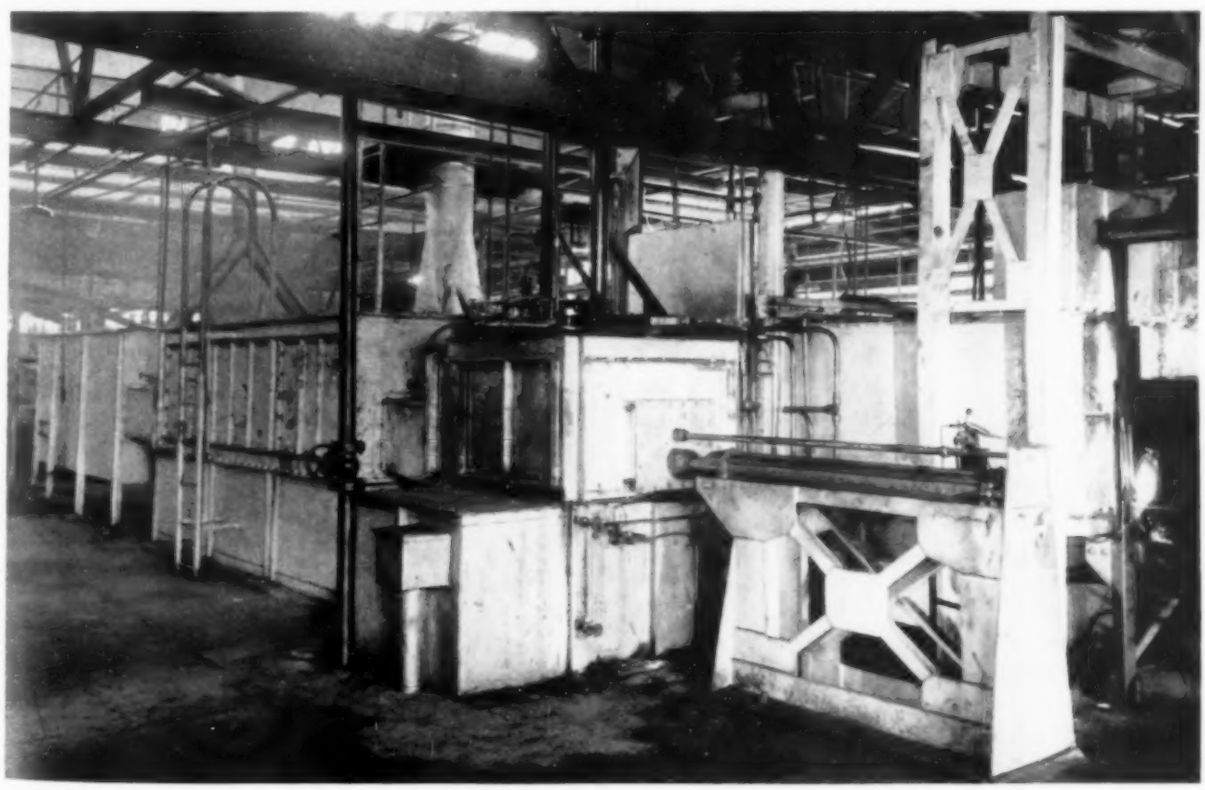
Trays that are to pass through the complete cycle are pushed through the last position of the cooling zone, past a door into the reheat where the temperature of the product may be raised as desired to temperatures around 1460° F. This arrangement of intermediate cooling and reheating has a decided advantage in strengthening the structure of the supporting metal beneath the case, and controlling the grain size.

At the end of the reheating period the loaded trays are pushed out onto an oil operated elevator and submerged into an exceptionally large oil quench tank. Interlocks and timing are so arranged that between 3 and 3¼ sec. elapse between the time the tray leaves the high temperature zone and the time it is immersed beneath the surface of the quench oil. After a submersion under conditions such that it is submitted to violent agitation in the oil bath, the cylinder automatically lifts the tray on the next cycle and it is pushed forward into a position where the excess oil will drain off. The second view, below, shows the equipment at this region. A considerable amount of the oil quench tank is below the level of the floor.

From the drain the tray-loads on their next stations are subjected to violent washing with high pressure sprays, first with strongly heated washing solution and second with hot water rinse to remove all trace of washing compound, leaving a clean surface. This washing equipment is intended principally to remove oil, as soot and dirt are non-existent, the usual carbonaceous deposit being eliminated by the design of the equipment, and do not occur in the carburizing zone.

While the gears are still hot from the final rinse, they are automatically transferred to the recirculating air draw which violently circulates a volume of gas around and through the tray

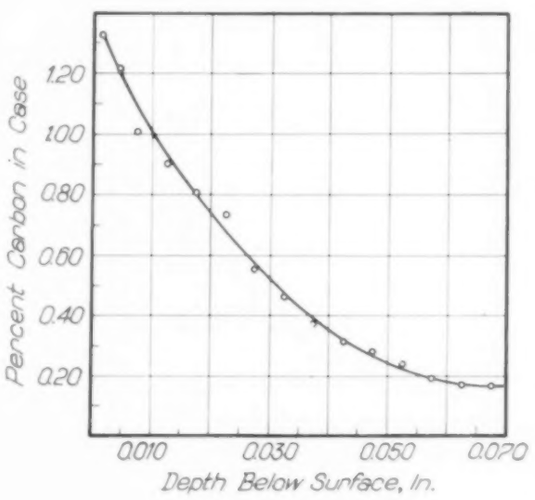
At Right Is Side of Reheating Unit; in Center Is Enclosed Oil Quench; at Left Is Cleaning and Washing Unit Leading Through Vestibule Into Chamber Where Work Is Tempered in Rapidly Circulating Flue Gases From the Carburizing Furnace



and gears. The temperature of the hot circulating gases is maintained by the controlled addition of hot waste products of combustion from the carburizing and reheating furnaces; no additional fuel is used. This operation is carried on without an excess of air, and, owing to the large volume of circulating gases at the correct temperature, extreme uniformity is obtained without any possibility of overheating any outwardly extending portions.

At the end of the draw furnace, the trays pass out through a vestibule which serves as an air lock to prevent the entrance of room air into the system. Since the entire equipment is arranged around a rectangle, the product is delivered on trays to the operator near the loading station. The operator unloads the gears to a conveyor leading to the inspection and grinding department.

One operator handles the entire output of the furnace, and oversees all of the operations specified. In addition there is one man on each shift who is connected with the metallurgical laboratory. He takes pyrometer readings, gas analyses and temperatures; he also inspects safety devices, keeps a log of all findings, and assists the operator when necessary.



Curve Showing Carbon Content at Various Depths, as Determined by Chemical Analysis of Lathe Turnings, of S.A.E. 4815-A Sample Carburized in Regular Production Cycle

One of the advantages of this equipment is the fact that the carburizing atmosphere may be either natural gas or normal city gas, and it is delivered to the carburizing chamber without modification of any kind. Interminable discussion has been devoted to the methods of treating various fuel gases to make them into suitable carburizing media which will not deposit an excess of soot or dirt. With this new unit no soot or coke is formed on the metal being carburized, even without any prior treatment of the gas employed. Since a layer of coke or soot greatly retards the formation of a proper carburized case, it is possible to carburize properly with a considerable reduction of the time previously considered essential.

Because of this more rapid operation, the size of the required furnace is substantially reduced, requiring less floor space and resulting in a lower investment.

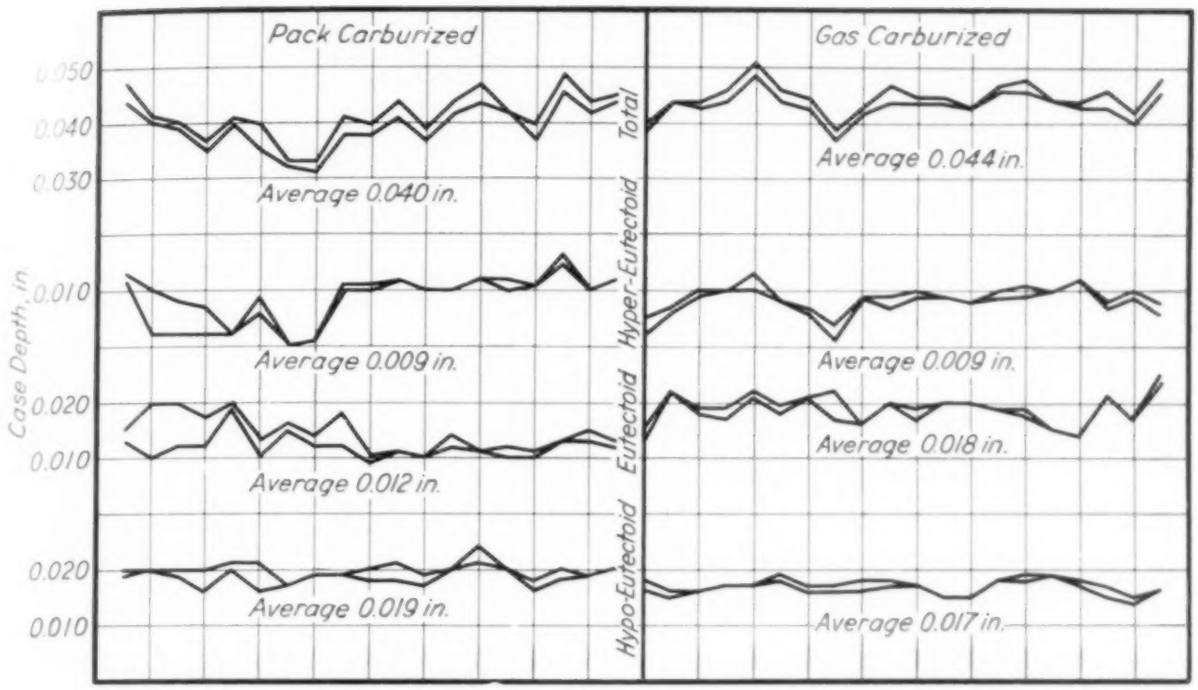
The equipment which has been described therefore offers somewhat novel results in the way of accelerated carbon penetration, greater cleanliness than has heretofore been possible, and unusual uniformity.

While the rate of carburization varies with a number of factors, some representative values will be recorded for gears made of S.A.E. 4815-A steel. When the average furnace temperature is 1440° F. in the first third of the chamber, 1680° F. in the middle portion, and 1690° F. in the remaining zone, and the time of through-put is 7 hr., the average depth of case hour by hour is as follows: 1 hr., 0.0045 in.; 2 hr., 0.011 in.; 3 hr., 0.022 in.; 4 hr., 0.032 in.; 5 hr., 0.036 in.; 6 hr., 0.0395 in.; 7 hr., 0.041 in. The accompanying graph also shows the results of carbon determinations of lathe turnings removed at definite increments from a carburized cylindrical test specimen.

Data are also presented at the top of the next page comparing the types of case obtained in box carburizing versus gas carburizing. Divergence of lines indicates degree of non-uniformity in case depth from side to side of sample. Note the much closer commercial uniformity of the recent gas process as compared to the former pack carburizing. Sections through a gear with a dead-ended hole show consistent case uniformity near the bottom of this hole and at all other points. Projections, holes, and even contact between adjacent parts do not affect the uniformity of the case.

Small Distortion Means Quiet Gears

Finally a chart is presented showing involute profiles of two clutch gears, one of which was treated in the continuous gas carburizer, and the other by packing in carburizing compound. Note the lack of distortion, which means better performance. In such studies as these, involute profiles are taken of four teeth 90



Log of Results, Shift by Shift, on One Design of Gear Carburized in Commercial Practice by Two Methods. Cases were checked at two places, diametrically opposite. Gas carburizing gives better uniformity, side to side, and day to day

apart on each gear. Both drive and overdrive sides of teeth are charted in an untreated state; and the same teeth recharted after treatment. To eliminate errors due to runout and mounting, charts of the four teeth are averaged and the final result shown. The involute profile shown by the broken line represents the gear before treatment, and the solid line after treatment.

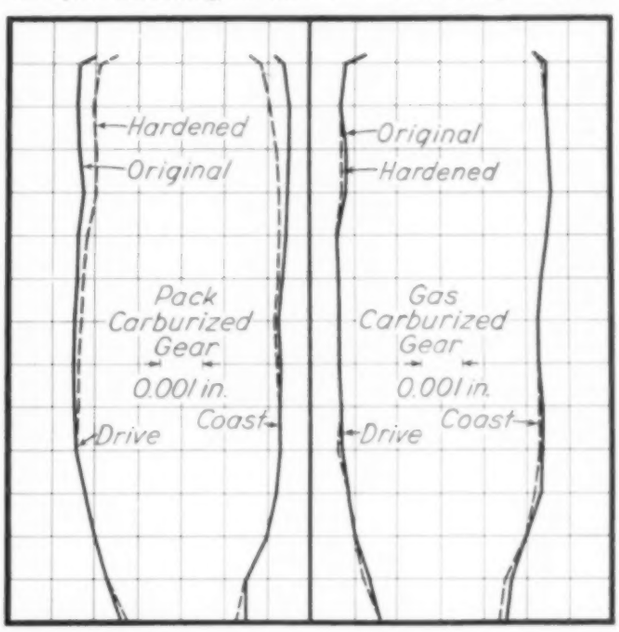
From the standpoint of operating costs, the new unit offers substantial advantages over the older conventional types. The matter of maintenance is only a fraction of that involved in the older muffle type units.

Fuel for the entire operation of carburizing, reheating and drawing ranges around 3400 cu.ft. of natural gas per hr. The atmosphere used for carburizing is slightly less than 300 cu.ft. per hr. of natural gas for the entire production specified. City gas may be substituted for natural gas satisfactorily.

Total operating costs are between one quarter and one third of the costs of the less satisfactory results of the older pack carburizing method.

Extensive tests have been made in laboratory and in service on the products from this furnace. It appears that the quietness of transmissions using gears treated by this process exceeds anything previously obtained by the more conventional carburizing and heat treating methods. The gears are quiet and give an extremely long life under heavy loads.

Profile of Involute Gears Before and After Heat Treatment. Details of measurement are given in the text, and show that distortions ranging up to 0.0005 in. after pack carburizing and hardening are reduced to about 0.0001 in. after hardening in the new heat treating machine



R. I. Nesmith and Associates

Boiler Makers

Photographed at Eddystone, Pa., in boiler shop of Baldwin Locomotive Works

Second Portion of a Paper Read Before the 1938 Western Metal Congress

By Edwin C. Wright
Metallurgist, National Tube Co.
and H. Habart
Metallurgist, Ellwood Works
National Tube Co.

typical failures of Still Tubes in refineries (b-alloy steel tubes)

IN THE FIRST portion of this paper, published in METAL PROGRESS last month, experiences and investigations were summarized on carbon steel tubes that had failed in service in petroleum refining stills. This second and concluding portion will consider troubles encountered with alloy tubes, principally of the 5% chromium steel and the 18% chromium, 8% nickel stainless steel.

The failures more commonly encountered during recent years, what with the improvement in design, operating practice, and use of alloy tubes, may be typified by Fig. 9, showing a tube made of 5% chromium steel containing 0.5% molybdenum. It will be noted that this tube is heavily scaled, the oxide coating on the outside being at least $\frac{1}{16}$ in. thick, and that the scale is permeated with longitudinal fissures or cracks which lead into the metal rupture. It is believed this condition represents a combination of oxidation and creep failure.

It has been generally noted that such heavily scaled tubes develop cracks in the scale, and the oxidation of the metal becomes accelerated at the base of the crack in the scale. This develops a slight notch and, as the tube expands slightly due to creep, the notch is opened and deepened by further oxidation. The tube wall usually thins out on one side, which is probably hotter in the still, and the hottest metal creeps to the greatest extent.

This is a gradual type of failure, which does not develop into a sudden rupture, and often ends with just a small pin hole leak or crack sometimes less than 1 in. long. The expansion of the tube is often less than 10% of the original diameter, and this reduced expansion is believed to be associated with the continual oxidation of the scale notch, which is first produced in the original cracking of the scale. This type of failure is emphasized since it has been represented in almost all of the tubes examined during the past five years. Carbon steel tubes and steel tubes made of other compositions also seem to fail in a generally similar manner.

Another instance of a 5% chromium, ½% molybdenum tube failure of this type is shown in Fig. 10 on the next page. The wrinkled outside surface and the penetration of the scale notch into the tube wall may be observed, while the transverse section shows how little the tube wall metal has been reduced in thickness except at the one spot where outside surface oxidation was accelerated. The thick-

Fig. 9 — Alloy Steel Tube (5% Cr, 0.5% Mo) Which Failed by Creep; Location Is Fixed by Accelerated Corrosion at Bottom of Cracks in Scale

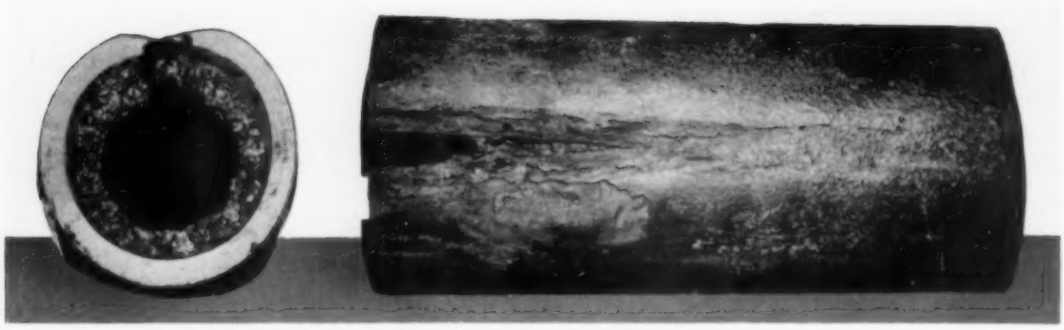


Fig. 10 — Notch Effect of Accelerated Corrosion Is Indicated by Localized Failure in Tube of Otherwise Normal Wall Section

ness of the coke deposit inside the tube is not abnormal, even today, and it is evident that many furnace tubes are "on stream" for too long periods between cleanings. This tube exhibits some interesting metal structures, indicated by Fig. 11 and 12, the first showing distinct carburization of the *inside* surface of the tube, from which it is inferred that the metal was heated in service to at least 1500° F. under the heavy coke deposit; Fig. 12 shows the refined, worked structure of the metal adjacent to the fracture.*

One of the most common causes of cracking tube failures is corrosion, and numerous examples of badly corroded tubes have been studied. They rarely exhibit anything of interest from a metallurgical standpoint, and no photographs of structure of badly corroded tubes are included.

In the case of the 18-8 chromium-nickel alloys, definite instances of corrosive failure have been studied. These tubes under ordinary conditions are largely immune to corrosion on the inside from the oils being processed, and are also highly resistant to oxidation on the outside.

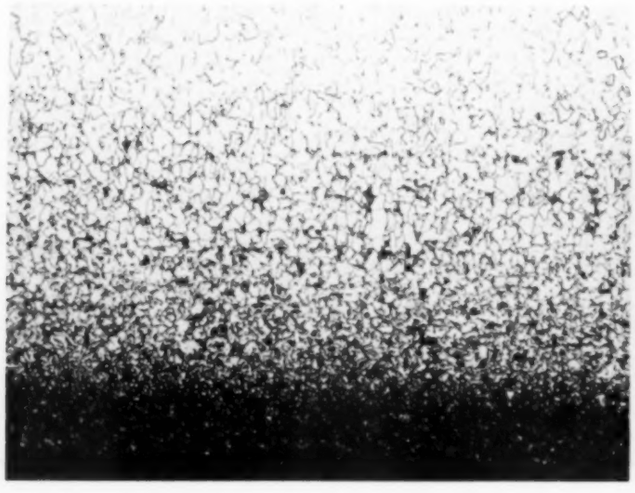
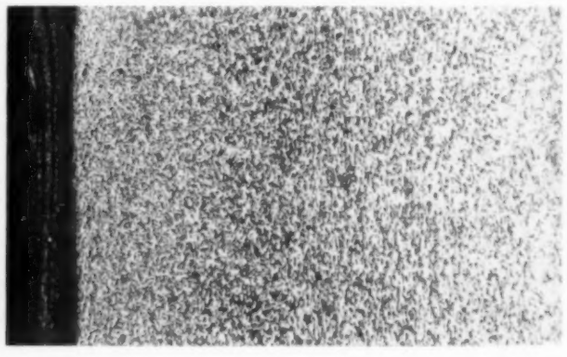


Fig. 11 and 12 — Carburized Inner Surface of 5% Chromium Steel Tube Indicates Temperatures of at Least 1500° F. in Service. At right: Refined, worked structure adjacent to crack also indicates failure by fairly rapid creep. Both micros at 100 diameters



***Editor's Note:** In discussing tubes made from steels of the 5% chromium type, no reference has been made to the brittle fractures, which were a source of considerable concern four or five years ago because, as the authors write, none of the National Tube Co. product has ever failed in this way, and it was thought inadvisable to discuss tubes made by competitors. It will be recalled that their brittle failures always occurred at atmospheric temperatures and never during the operating cycle of the still. A detailed study of this type of trouble has been made by H. M. Wilten and E. S. Dixon of The Texas Co., and their observations have been recorded in two notable papers, one in **Proceedings** of the A.S.T.M. for 1934, and one in **Transactions** for 1935. They found no evidence of microstructural change in the metal and the cause is therefore quite obscure and not yet explained satisfactorily. Fortunately the trouble has been confined to the plain chromium steels, and has been eliminated by the addition of 0.5% molybdenum to the analysis. Existing installations of plain chromium steel tubes should be cleaned while warm.

Under certain conditions of structure, stress, and temperature, however, the 18-8 alloy has exhibited cases of intergranular failure originating either on the inside or outside from intergranular corrosion. Half sections of 18-8 alloy tubes are shown alongside in Fig. 13 which had begun to fail on the inside. Upon investigation they were found to have been attacked and suffered from intercrystalline disintegration. The structure of the metal under these corrosion fissures is shown below in the two photomicrographs, Fig. 14 and 15, reproduced at 100 and 1000 diameters magnification respectively.

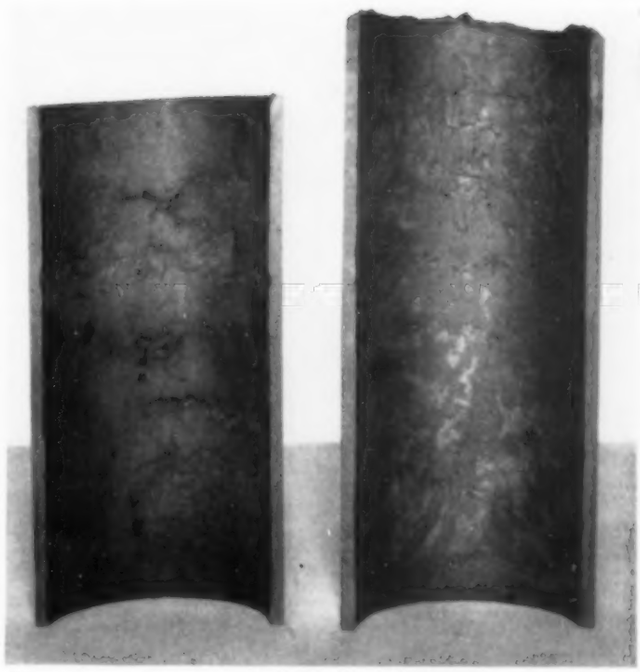


Fig. 13 — Two Samples of 18-8 Tubing, Superficially Cracked by Interior Corrosion in Intergranular Type

A definite case of intercrystalline oxidation on the outer surface is shown in Fig. 16 on the next page; the tube surface is honeycombed with fine intercrystalline cracks. The structure of the metal at this disintegrated region is exhibited in Fig. 17. Figure 18 at 1000 diameters, is of considerable interest in that it shows the metal structure near the contact with the oxidizing gases. The white streak of metal between the two layers of oxide apparently represents the original grain boundary between the neighboring crystals, and the oxidation has taken place along the grain boundary surface of the original crystal where the chromium was depleted through carbide precipitation. Perhaps the remaining metal film at the exact boundary is exceedingly high in chromium carbide, concentrated in this position. The theory has long been held that, when carbide precipitation occurs in chromium-nickel alloys, the separation of the chromium carbides, which are high in chromium, causes a reduction in chromium content in the metal adjacent to the precipitate. This lower chromium content near the grain boundary reduces its corrosion resistance and, therefore, accelerates the attack of the corroding agent.

This brief summary of our accumulated investigations over the past 20 years has been

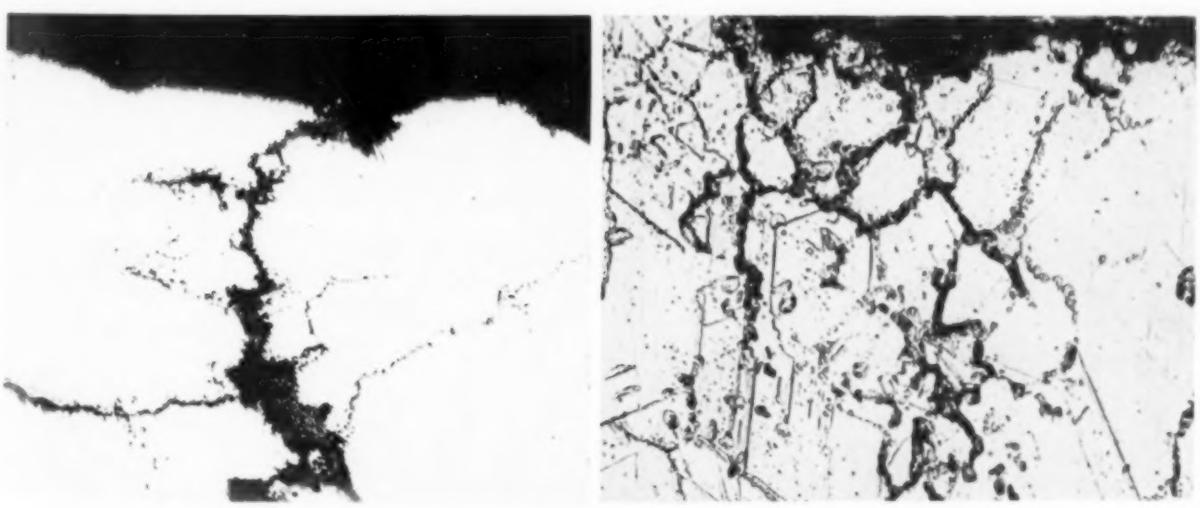


Fig. 14 and 15 — Microstructure of Metal Alongside Crack (at 100 and 1000 ×, Respectively) Showing Extent of Disintegration and How the Attack Favors Material at Grain Boundaries. Unetched and etched with Vilella's reagent, respectively

Fig. 16 — Sample of a Tube of 18-8 Stainless Steel Which Failed From External Oxidation Penetrating the Intercrystalline Material

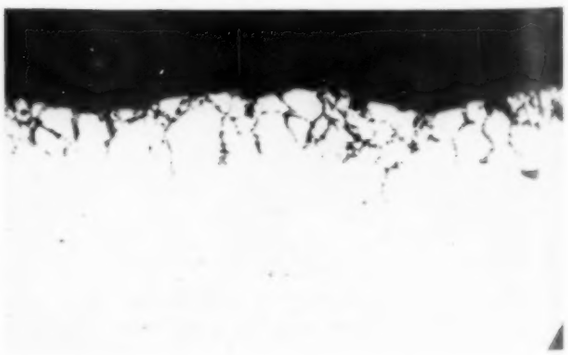
compiled for the interest of refinery engineers using petroleum still tubes. In this period, great advances have been made in the design, operation, and control of petroleum cracking equipment, even though more severe conditions were gradually being imposed upon it. It is now possible to process the most corrosive crudes and to conduct polymerization and reforming operations at temperatures and pressures which were unheard of 15 years ago. With these advances in the cracking art, the general average life of still tubes has also been greatly increased in spite of more difficult conditions.

It results that petroleum still tubes, which previously would not have lasted any more than 2000 to 10,000 hr., are now being used for periods of 30,000 to 60,000 hr. This has come about to a large extent through improvement in tubes and tube metals, but more particularly through advances in design and in operating control of cracking still furnaces. In 99% of the tube failures which have been investigated, there have been no examples of really defective steel or poor workmanship in tube manufacture, and this has been particularly true during the past five or ten years. There have been, however, very great improvements in the design and construction of cracking still furnaces, and much greater care in supervising the cleaning of the tubes, gaging their wall thickness, and observing the coil for hot spots at frequent intervals during operations.

It is believed that this long period of experience has proved the ability of the metals used to withstand extremely severe punishment. This experience indicates that a refinery operator, carefully regulating his cracking conditions, can use tubes properly selected from a variety of analyses with good assurance both for economical operation and safety. The fact that cracking coils are now built to handle up to 40,000 barrels per day of crude petroleum at pressures of at least 1000 lb. and at outlet vapor temperatures as high as 1050° F. is good proof that engineers in that industry can design their equipment with complete confidence, using steel tubular materials now available.

Many persons have contributed to this paper through work done in the past. The writers wish particularly to thank R. H. Aborn of the U. S. Steel Corp. Research Laboratory, R. W. Moore of the general laboratories of Socony-Vacuum Oil Co., and Wayne Colmery, metallographist at the Ellwood Works of National Tube Co. for their help and many suggestions.

Fig. 17 below, and 18 at left — Unetched Micro at 100 × Showing Surface Layer Honeycombed by Hot Oxidizing Gases, and (at Left) View at 1000 × of Penetration Into Metal. The bright thread is the locus of an original grain boundary, high in chromium carbides; the gray layers on either side are corroded metal, depleted in chromium by carbide precipitation, and hence more corrodible

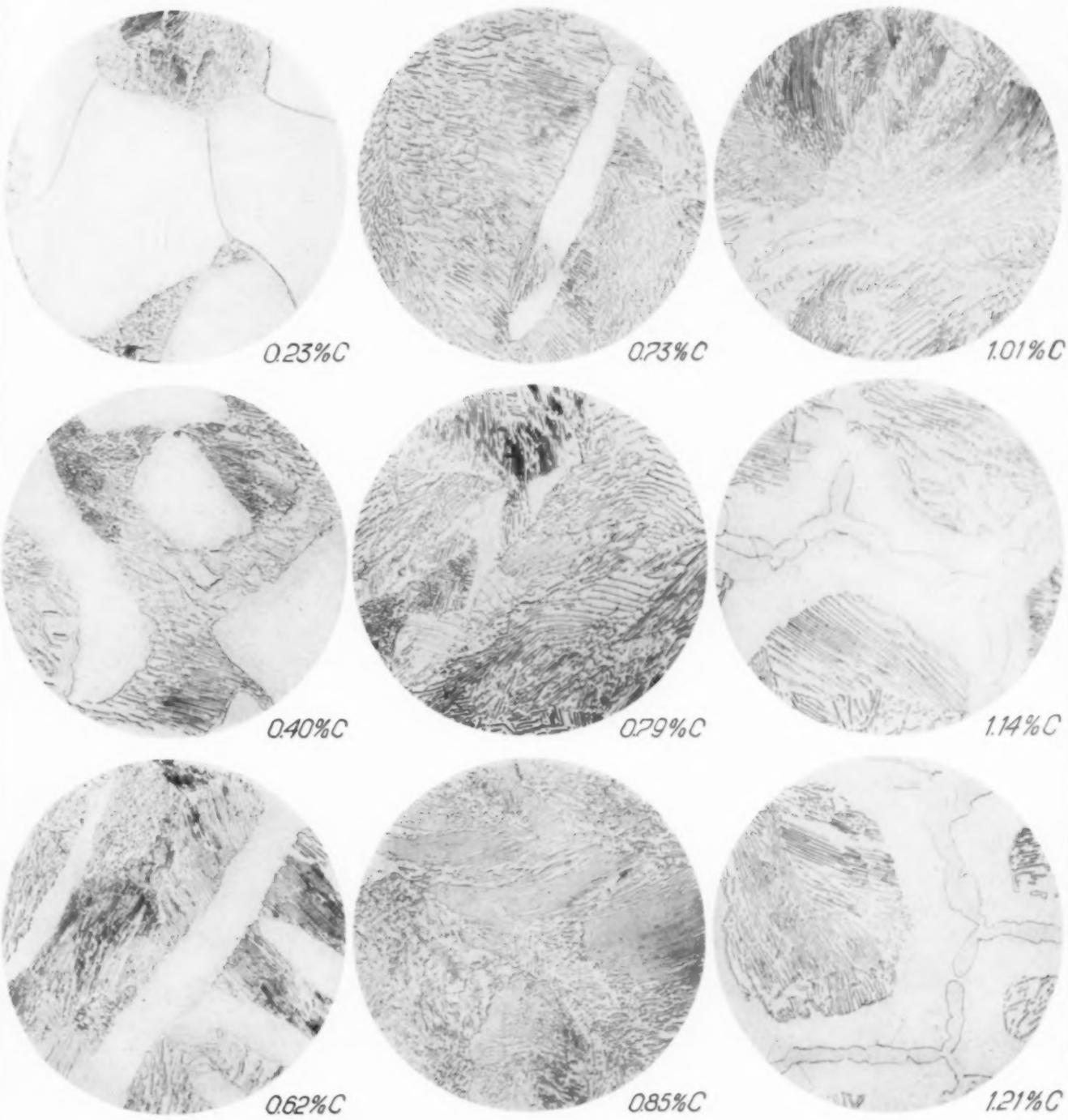


DECEMBER, 1938; PAGE 688 METAL PROGRESS

High Purity Iron-Carbon Alloys

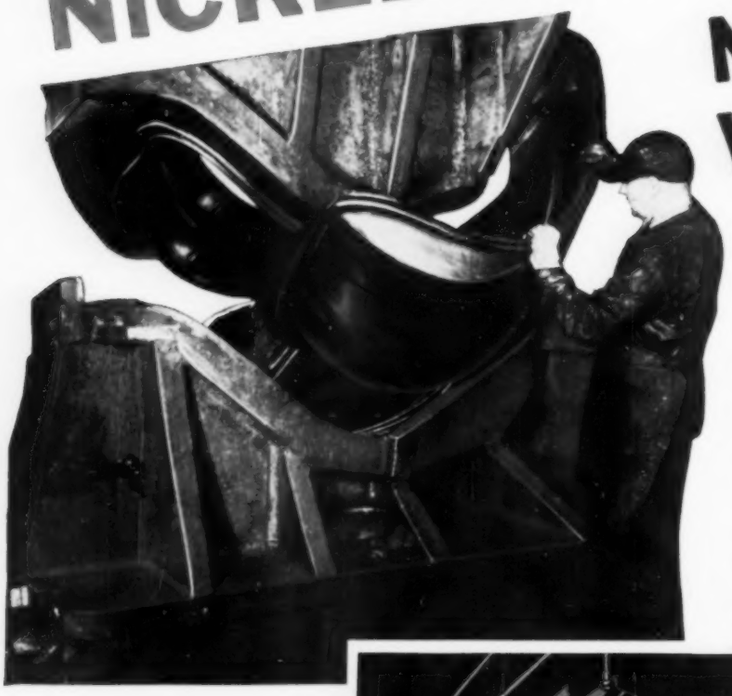
By Harry K. Herschman, Metallurgist, National Bureau of Standards

Approved for publication by the Director

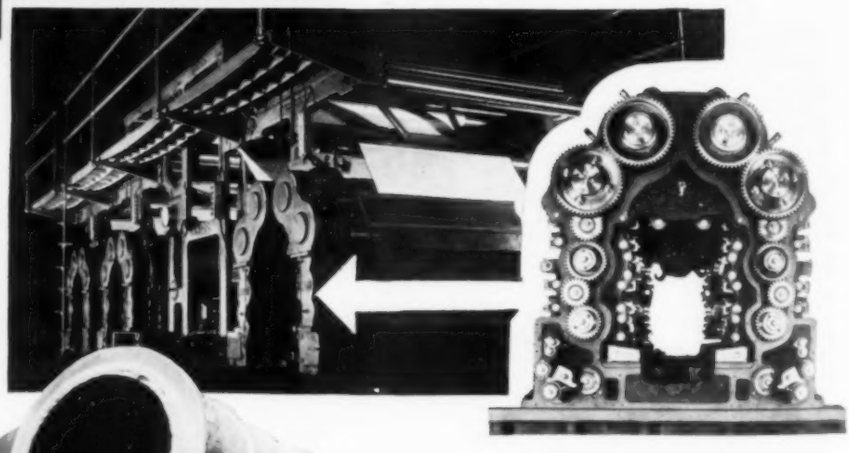


Alloys prepared by Thomas G. Digges (see **Transactions** ⊜, vol. 26, 1938, p. 408) by carburizing vacuum-fused electrolytic iron in a mixture of hydrogen and benzene, then homogenizing by heating at 1700° F. (925° C.) and rapidly cooling to room temperature. Specimens were then reheated to 1700° F. for one hour and cooled to 1020° F. (550° C.) at an approximate average rate of 5° F. per min. The homogenizing and annealing treatments were made in vacuo. Total impurities, by analysis, less than 0.03%. Etched in equal parts of 1% HNO_3 in alcohol and 5% picric acid in alcohol. Magnification 500×.

NICKEL *turns the oldest metals to* NEW and WIDER USES



Among the metals whose commercial use dates back for centuries is cast iron . . . a material that has always been highly respected for its adaptability, machinability and low cost. Times have changed . . . so has cast iron — thanks to scientific foundry practice and the intelligent use of alloying elements — principally Nickel. Considerably stronger, harder and more wear-resistant than the unalloyed product, Nickel Cast Iron is economical for many modern applications. For example, the Nickel cast iron fender forming die pictured here is capable of stamping out more than 30,000 automobile fenders without redressing. This performance is 3 to 6 times greater than is possible with plain grey iron and results in fewer interruptions of the production schedule for regrinding operations as well as appreciable reductions in maintenance costs.



Here is a modern newspaper press manufactured by Goss of Chicago in which all the gears are made of Nickel Cast Iron. In selecting this material for this application, Goss engineers were able to take advantage of the initial economy of cast iron. In addition, they obtained gears capable of withstanding the stress and wear of high speed operation — thanks to Nickel.

NICKEL CAST IRONS

Modern railroads cannot tolerate excessive locomotive failures. For instance, in cylinders, due to the trend towards greater tractive effort at high speeds, higher boiler pressures and superheated steam with its increased cylinder temperatures, strength, density and pressure tightness are the prime requisites. That is why railroads are turning more and more to Nickel Cast Iron for this purpose and various other applications demanding these all-important properties.

Our casting specialists will be glad to consult with you and suggest where the Nickel Cast Irons will effect economies in your plant or equipment.

THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N. Y.

Book Reviews

Ancient Copper

TREATISE ON COPPER (Opera Philosophica et Mineralia, v. III) by Emanuel Swedenborg. Translated by A. H. Searle. 3 volumes, 536 mimeographed typewritten sheets, 8x13 in. Published in collaboration with the Swedenborg Society by British Non-Ferrous Metals Research Asso., London, N. W. 1., England. Price 28 shillings, postpaid.

Reviewed by Lawrence Addicks

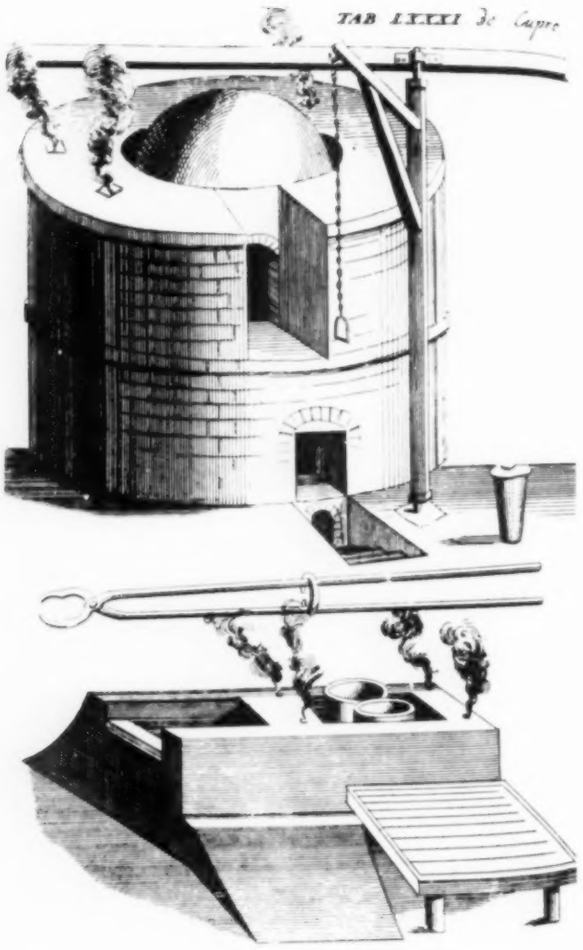
Emanuel Swedenborg stirred such bitter controversy in the field of theology, to which he exclusively devoted the last 30 years of his long life, that the really notable contributions he made to philosophy and science were long buried in the original Latin. In fact his name can seldom be found in popular histories of science although he contributed largely to such varied fields as astronomy and anatomy, and his partisans claim he anticipated much of modern physics and chemistry. He was a close observer and held that every ten mathematicians should have a practical man attached to the group to "take them to market".

His earlier work in metallurgy stemmed naturally from his post as assessor, or member of the governing board, of the Swedish Royal Department of Mines. In the course of his duties he visited most of the mining regions of Europe and noted down with meticulous care every detail of what he saw. Sweden then was an important producer of iron and copper. "Swedish iron" is still famous and in manuals as late as Gee's "Goldsmith's Handbook" the equal of "Swedish copper" is called for in making jewelers' alloys.

The book under review, "de Cupro", published in 1734, has been painstakingly translated by one confessedly not familiar with smelting details; it lacks the prop of the excellent illustrations in the Latin original, with the result that many descriptions seem needlessly repetitive and operations are at times hard to follow. The minimum of editing does avoid the introduction of anachronisms and is doubtless justified, but it is to be hoped that a way will be found to issue an appendix reproducing these cuts and some explanatory notes.

The subject matter covers descriptions of the processes used in each locality for the treatment of the complex sulphides from which copper was then recovered, the precipitation of mine waters, the manufacture of brass, bronze and bell metal, special uses of copper and full details of assay methods. Each mine had its own practice, depending on the impurities present, but in general the ores were subjected to innumerable oxidations and reductions in furnaces not much larger than dog kennels, passing through matte and white metal to black copper which was then fire-refined much as at present (allowing for the toy scale of the equipment). Months were required for the complete cycle of operations and a few thousand pounds of copper a year seems to have been a paying venture for a smelter. If silver was present lead was added as a collector, being later separated from the copper by liquation and then cupeled.

It is impossible to say anything adequate on such a work in the space permitted to a technical book review. It is naturally of only historical interest today, but its perusal is not without reward to modern metallurgists. One is struck at first by the little progress made from Agricola's time, nearly 200 years before — but that line of thought leads one to humility when considering the time it took the elements of present practice to take shape after the chemical mysteries of those days had been cleared away. It is almost impossible to realize that Lavoisier had not yet been born and that the book must have been written with but the vaguest idea of the nature of any chemical reaction. Rarely alchemy enters with a prescription for powdered crabs' eyes as a reagent or the consideration of the precipitation of copper on iron as a transmutation, but such statements are always in quotations from others and Sweden-



Furnaces for Making Brass, Sketched at Ochran in the Tyrol, circa 1734 (Fig. 81, from "de Cupro")

borg himself seems to have well studied "the famous Boyle" and have possessed much intuitive perception of the chemistry of a later day. Strangely too, there is nothing speculative in the work, which is a sort of textbook with descriptions of the processes then in use and copious quotations from known authors. Incidentally it must have constituted a wholesale disclosure of trade secrets!

The book lacks the charm of style of the Hoovers' translation of Agricola but this may be due in part to the literalness of the translation. It is enlivened at times by such expressions as "a bolster for the jowls of Eolus" in describing a support for a blast pipe, and American readers will be interested in the location of a mine as "in Pennsylvania or New England in New Jersey". Our author also pays his respects to a would-be process-seller when he remarks that the ore "loves experience better than theory and mocks at clever chemists more than at its own experts". That the index carries references to 160 persons and 396 places will indicate the thoroughness of the survey.

Perhaps the greatest reward to the reader of this treatise will be that before he is through he will find that he has browsed through whatever he can lay his hands on connected with early metallurgy, the history of Sweden and the remarkable life of Swedenborg himself — a large but pleasant order.

For Nordics Only

GERMAN GRAMMAR FOR CHEMISTS AND OTHER SCIENCE STUDENTS, by John T. Fotos and John L. Bray. 323 pages, 5½x8 in. John Wiley & Sons, Inc., New York. Price $2.25.

Reviewed by Marjorie Rud Hyslop

For the metallurgist who undertook to get a reading knowledge of German from one of the sketchy courses offered by colleges to comply with requirements for the Ph.D. degree, and who still attempts with great expenditure of painstaking effort to read or translate German scientific literature, this new grammar by members of the Purdue faculty should take its place next to Freeman's well-worn and much-thumbed *Fachwörterbuch der Metallurgie* published about five years ago.

This book does not make the common mistake of starting out with much reading and little grammar. Rather the essentials of German grammar are presented in such compact and meaty form that this reviewer (who belongs in the category mentioned above) found that after spending a half hour to an hour a day mastering the rules and doing the exercises and translations given at the end of each lesson, a week was consumed in covering only the first four lessons (29 pages)! While the book seems to skip around in an unconventional way — it does not tackle adjectives at all until Lesson XVII — the arrangement is not as confusing as it might appear, and of course is so planned as to allow for simple translations from the first lesson on. These translations and vocabularies are devoted entirely to scientific terms and reading, such standbys as *Mutter*, *Apfel* and *Garten* being entirely disregarded.

Not to be overlooked is a more complete list of general and scientific abbreviations than is contained in any dictionary. A little more attention to black face type might have been appreciated by beginners who have to wrestle with a dictionary so printed.

Elements

METALLURGY, by Carl G. Johnson, R. S. Dean and J. L. Gregg. 150 pages, 5½x8¼, 82 illustrations. Published by American Technical Society, Chicago. Price $1.50.

Let those who jibe at three such men as a professor at Worcester Tech, chief chemist of the U. S. Bureau of Mines, and metallurgical researcher at Battelle Memorial Institute collaborating on an elementary text (reading time 2 hr. 30 min.) try to write briefly about the science of metals in a way a beginner can understand, and to say something about the important phases of metallurgy — extraction, fabrication, heat treatment, and test methods, not only for steels but for non-ferrous metals and alloy systems, not excluding a liberal section about what is now coming to be known as "physical metallurgy" — and to do this without talking down to the reader, elaborately using words of one syllable, or marking pronunciation on such words as gangue. He then will know what a difficult job has been done and done well. In fact, it will be the reviewer's standard recommendation to those ambitious ones who wish a "simple book about metals". The eminent authors (whose method of collaboration is unknown) have successfully resisted what undoubtedly was a constant temptation to talk as to intellectual equals about things of specialized importance, except in such rare instances as when they devote a short paragraph to a metallurgical curiosity like electrolytic iron, and give as a reference for further reading "The Metallic State" by Hume-Rothery (the printer insisted that there *could* not be a name like that — it must be two men!).

Manual of Heat Treatment

STEEL AND ITS HEAT TREATMENT (Volume I; Principles, Processes, Control) by Dennison K. Bullens. Fourth edition, revised by metallurgical staff of Battelle Memorial Institute. 445 pages, 6x9 in., 209 illustrations. John Wiley & Sons, New York. Price $4.50.

Reviewed by Ernest E. Thum

It is striking comment on the tempo of modern industry that "Bullens' Heat Treatment", has become obsolete, even though the last thorough-going revision was published in 1927. Examination of that third edition shows no definition of the word "normalize", no intimation of grain size control and the single quench for carburized parts (its first and most important industrial application), nothing on controlled atmospheres other than carburizing. Insertion of matter on these and other developments has practically doubled the text of the third edition, so that this, the fourth, appears in two volumes. Volume II, containing specific information on the various common, engineering, and special purpose steels, is promised early in 1939.

Bullens was a practitioner rather than a researcher. Consequently the pedant could readily find fault with some of his statements of general principles and theories — even in this new edition. However, the theoretical matter was clearly enough stated to form a logical base for a vast amount of good information on how to do a given job. Bullens also was always correctly insistent on the necessity of controlling the human factor. Again indicative of present trends is the circumstance that many of the important changes during the last ten years — improvements in steels, furnaces, auxiliaries and instrumentation — are designed to eliminate or minimize that very item, the personal element in heat treating operations.

In this new book the text of the third edition has been retained in great measure, subject to editorial corrections and interpolated with paragraphs or even pages on new aspects of the old subject. The first chapter on testing of steel has been expanded from its original 20 pages to 75, and now forms the most inclusive statement on the subject the reviewer is acquainted with. Masterpieces of condensed writing are also the new chapters on normalizing and "austempering", grain size, precipitation hardening, controlled atmospheres. One recognizes the work of Dr. H. W. Gillett in these pages, and the result of much practice with "correlated abstracts" and the type of writing utilized by the Alloys of Iron Monographs. To this reviewer it is not especially readable; more important, it is very informative.

It is to be hoped that a relatively small edition has been printed — say a two or three years' supply — for some of the new text describes matters that are still in a state of development, notably that on controlled atmospheres. A nearby fifth edition will not only avoid early obsolescence but also enable the publishers to correct two defects, namely, poor copy reading and (much more serious) micrographs which were second class even ten years ago.

Correspondence

Hardening of Metals by absorbed gases

PARIS, *France* — Metals prepared by electrolysis are often found to be hard and brittle and to contain a considerable percentage of gases, particularly hydrogen; softening, removal of gases and recrystallization of the metal can be effected by annealing. Similar observations may be made when a metal plate or wire is charged with gas by electrolysis.

This phenomenon has led to widely divergent interpretations and also to controversies in attempting to explain the hardening. The mechanism, however, now seems to be elucidated by X-ray spectrographic studies and especially by a new process for cold degasification of metals.

This process consists in submitting the metal to ionic bombardment by making it the cathode in a vacuum discharge tube; the voltage between the terminals may be as high as 150,000 volts and the current 5 milliamperes. The cathode does not heat and the gases are removed and evacuated at low temperature.

The results thus obtained as to gas content agree with those provided by chemical methods (when such methods are possible, as in analyzing for nitrogen in aluminum); they also agree with results obtained by high temperature vacuum extraction (as in the case of palladium and tantalum) or, on the other hand, they may be far different (as in the case of gases in iron). The extraction rate is increased by raising the temperature, thus accelerating the diffusion of gases in the solid metal.

Selective removal of the gases may be observed. For instance the gases removed from aluminum contain CO_2, N_2, CO and H_2; of this group CO_2 disappears first, then N_2, then CO, leaving only H_2 for final removal.

This process, capable of being used at ordinary temperature, without consequent modification of the crystal structure, gives an invaluable method of separating the two phenomena — degasification and recrystallization — which occur simultaneously during heating or annealing in a vacuum.

Experiments on aluminum, iron, palladium and tantalum have demonstrated the important fact that cold degasification does not modify the hardness nor the crystal structure. Instead the crystal structure remains deformed and distorted; the grain is larger and the lines of the X-ray spectrum are fuzzy as in a cold-worked metal. If the degasified metal is then annealed, the grain resumes its original form and the lines of the spectrum become fine and clear while the hardness and the electrical resistance again become normal.

For example, when charging palladium with hydrogen by electrolysis, the grain is enlarged by more than 0.1 Å, increasing the resistivity by about 70% and the Brinell hardness number by about 50%; after cold removal of the gas these properties retain their respective values. The presence of hydrogen, therefore, is not the immediate cause of the change, but rather merely distorts the crystalline lattice putting it in unstable equilibrium which is removed by the atomic mobility induced by tempering.

In iron the crystal grain varies little (0.001 Å), but the fuzziness of the lines denotes the distortion of the crystalline lattice, the hardness number being tripled.

The phenomenon seems therefore to be a sort of cold working by gas atoms, a cold working which remains after removal of the gas, just as cold working by mechanical deformation remains after the purely mechanical action has ceased.

These investigations have led to two characteristic and rather unexpected results:

1. Electrical resistivity of a metallic wire

may be increased by the temporary introduction of hydrogen atoms, just as by mechanical cold working. This has been tried with iron and high purity aluminum, and its resistivity increases from 2.65 to 2.86 microhms per cm. with a temporary introduction of 340 cu.cm. of hydrogen per 100 g. of metal. (An introduction of 228 cu.cm. caused no change.) Resistivity and hardness of a metal can thus be modified by a chemical action which leaves no trace.

2. The flow of gas along a metallic wire or band transmitting a gas current by diffusion may be effected in the following manner: One end of the metallic wire or band is submitted to ionic bombardment and the other end is placed in hydrogen. This experiment can be used to good advantage in studying the influence of cold working and of electrical current upon the rate of diffusion of gases in metals at ordinary temperature.

ALBERT PORTEVIN
Bessemer Medallist

Welded Valve Bodies

TURIN, *Italy* — Very few changes have occurred in Europe during the last few years in the manufacturing of steam and water valves. In special cases the regular cast or forged elements had been replaced by pieces obtained from stamped and welded plates or tubes. Since the design of such valves was usually quite different from normal, this was a serious hindrance for the general adoption of the new system of construction.

This difficulty seems to have been removed by a new process (covered in all the industrialized countries by the so-called Santamaria patents, and adopted by the Cantieri del Tirreno in Genoa) for the regular mass production of valves of all types, wherein practically all castings are replaced by stamped and welded plates without changing the design of the valve other than reducing the thickness of walls.

The new type of construction for valves of the disk, ring, step, or cup types, is based on utilizing the inner diaphragm which carries the seat as the element where connection is made between the two stamped half-bodies.

For slide valves the body is formed by two stamped pieces welded along a transverse or longitudinal plane, while the tubular connections are prepared separately and welded, each in one piece, to the body. Special devices have been studied for the economical construction of all known classes of valves, corresponding exactly to the standard designs normally adopted for each.

The arc welding process is adopted, and welding is always done outside the valve body. When using ordinary carbon steel plates with 60,000 psi. tensile strength, and 22 to 25% elongation, the weldrod or electrode should have about 75,000 psi. tensile strength, with 20 to 24% elongation.

A few examples of the thicknesses usually adopted for ordinary welded valves made from carbon steel plates, as compared with ordinary cast valves of same dimensions and types, are quoted in the table at the foot of the page. Taking into account the reduced thickness of flanges, the average saving in weight for this class of valves exceeds 30%.

Much greater savings in weight are obtained for valves of alloy steels (and especially for stainless steels). There are other important technical advantages, such as a greater resistance to vibration, absence of porosity, a higher resistance to impact, and the commercial advantage of lower cost.

Another important advantage of the new process of construction lies in the fact that the various parts of the valve are completely finished separately, before they are connected to form the valve body. Under these conditions it is easy to use the most suitable materials for different parts of the valve. For instance, all bronze pieces can be eliminated and replaced by austenitic steels, welded on the valve seat. This replacement has shown great advantages where the danger of electrolytic corrosion is likely to be serious.

Mass production of the new type of valves, especially for naval use, was only started a few months ago, and is at present in full development.

FEDERICO GIOLITTI
Bessemer Medallist

Comparative Wall Thickness (Inches)

Internal Inlet Diameter	Test Pressure 85 Psi.		Test Pressure 170 Psi.
	Cast Iron	Cast Steel	Welded Steel Plate
1.5 in.	0.35	0.20	0.12
2	0.40	0.25	0.16
3	0.55	0.42	0.30
6	0.75	0.63	0.40
10	1.00	0.75	0.55

Grain Size Standard

CHICAGO, *Ill.* — Since many members of American Society for Metals are specifying and using steels of controlled grain size, they will be interested in a proposed Tentative Standard for Austenite Grain Size, adopted recently by the American Society for Testing Materials. The undersigned, chairman of the sub-committee which fathered the specification, will welcome any comments as to its suitability. Such comments will be given careful consideration before the Tentative Standard finally becomes an A.S.T.M. Standard.

MARCUS A. GROSSMANN
Director of Research
Carnegie-Illinois Steel Corp.

Proposed Austenite Grain Size

The Chart — The chart (not reproduced) consists of a series of grain outlines, representing the grain sizes which one may expect to encounter in the austenite of various steels, at various temperatures in the austenite range.

Ascertaining Austenite Grain Size — Numerous methods are in use for establishing austenite grain size, and a knowledge of grain-coarsening behaviors is helpful in deciding which method to use. The size of austenite grains, in any particular steel, depends primarily on the temperature to which that steel is heated and the time it is held at the temperature. It should be remembered that the atmosphere in heating may affect the grain-growth behavior at the outside of the piece. As may be agreed upon between consumer and producer, austenite grain size shall in this standard be determined either (a) by carburizing at 1700° F. for eight hours — the McQuaid-Ehn test — which is recommended for carburizing grades, or (b) by heating at a temperature not over 50° F. above the normal heat treating temperature and for not over 50% more than the normal heat treating time, the normal values being those mutually agreed upon. The rate of cooling depends on the method, as will be evident from the following itemizing of methods.

Methods commonly used at present for revealing austenite grain size are (1) by outlining the grains with cementite, as in carburizing — McQuaid-Ehn test — or as in high carbon steels, or (2) by outlining the grains with ferrite, as in the hypo zone in carburizing, or in medium carbon steels generally, or by an interrupted cooling on low carbon steels, or (3) by fine pearlite outlining martensite grains, as in eutectoid steels at a not quite fully hardened zone, or (4) by appropriate etching of fully hardened martensite, or (5) by an oxidation method.

The measurement of grain size is carried out by comparing the microscopic image at 100 diameters magnification with the standard grain size chart. Absolute grain sizes may be calculated from the adjoining table, which shows the sizes as they appear in the chart and also the sizes in reality.

Larger sizes, 00 and 0, may be read by using a magnification of 50 diameters (instead of 100) and using No. 1 and 2 on the chart respectively, and smaller grain sizes, 9 and 10, may be read by using a magnification of 200 diameters (instead of 100) and using No. 7 and 8 on the chart, respectively. (With the present state of the art of steelmaking, the commercial size ranges 1 to 4 and 5 to 8 suggest coarse and fine ranges respectively.)

In reporting grain size, the test conditions should be stated.

Fracture Method — There are in use today sets of fracture standards, in which the grain size is judged from the fracture appearance. It has been found that the arbitrarily numbered fracture grain sizes agree very well with the arbitrarily numbered grain sizes presented here. This coincidence makes the fracture grain sizes interchangeable with the austenite grain sizes determined microscopically (except that "duplexing" or mixed grain size is not readily discernible in fractures). The sizes determined microscopically should be considered the primary standard, since they are measurable with measuring instruments.

Table of Sizes

A.S.T.M. Grain Size Number	Mean Number of Grains Per Sq.In. as Viewed at 100 ×	Calculated Diameter of Equivalent Spherical Grain (Not Magnified)		Calculated Mean Area of Cross-Section of Grain (Not Magnified)
1	1	0.0113 in.	0.287 mm.	0.000 1 sq.in.
2	2	0.00800	0.203	0.000 05
3	4	0.00567	0.144	0.000 025
4	8	0.00400	0.101	0.000 012 5
5	16	0.00283	0.0718	0.000 006 25
6	32	0.00200	0.0507	0.000 003 13
7	64	0.00142	0.0359	0.000 001 56
8	128	0.00100	0.0254	0.000 000 78

Remarks — Austenite grain size is influenced by most previous treatments to which steel may have been subjected, as for example quenching, normalizing, hot working and cold working. It is therefore advisable, when testing for austenite grain size, to consider the effects of prior or subsequent treatments on the precise piece (or typical piece) which is under consideration.

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And day and night, the country over, these oft-repeated words reflect the value of the telephone . . . "I'm glad you called."

BELL TELEPHONE SYSTEM

Personals

Appointed district manager of the Philadelphia territory for Bliss & Laughlin, Inc.: **J. Stanley McCord**, formerly of the Cleveland office.

Walter H. Braun is now in the metallurgical department of the Rustless Iron and Steel Corp. in Baltimore.

Weston Hare has left the position of research engineer, Timken Roller Bearing Co. Steel & Tube Division, to accept a position as research chemist for E. I. du Pont de Nemours & Co., Rayon Research Division, Buffalo.

E. Trantin, formerly chief metallurgist Stewart Warner Corp., is now assistant superintendent of Thompson Wire Co.'s new Chicago plant.

Announcement!

Intensive research has just completed important improvements in the field of heavy-duty gear and bearing lubrication.

As in 1931, D. A. Stuart Oil Co.'s pioneer development, "STURACO" EP Gear and Bearing Lubricant, again widens the field between it and competitive products.

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Jesse M. Darke, metallurgist and director of the materials testing laboratory at the Lynn Works of General Electric Co., has retired after 46 years of service.

Elected a member of the Executive Committee of the American Society for Testing Materials: **J. R. Townsend**, materials standards engineer, Bell Telephone Laboratories, Inc.

William G. Praed, formerly metallurgist at Stewart Warner Corp., is now representing C. I. Hayes, Inc.

Leland L. Pelligren, formerly junior metallurgist at International Harvester Co., is now research metallurgist at Chicago Steel & Wire Co.

Thomas G. Harvey, formerly metallurgist for Edison General Electric Appliance Co., is doing graduate work in metallurgy at the University of Wisconsin.

John H. Abbott has resigned from Timken Steel & Tube Co. to become manager of alloy sales for Rotary Electric Steel Co.

Transferred to U.S. Steel Corp. Research Laboratory, Kearny, N.J., as research assistant: **John M. Kiefer**, formerly assistant metallurgist at Cuyahoga Works, American Steel & Wire Co.

Warren H. Mayo has been made foreman of heat treating procedure at the Homestead Works of Carnegie-Illinois.

Awarded International Nickel Co. fellowship in metallurgy for 1938-39: **George E. Pellissier**, at Carnegie Institute of Technology.

Howard Middendorp, University of Minnesota '38, is now in the heat treating department of Caterpillar Tractor Co. in Peoria.

James B. Hess has been made junior metallurgist at J. H. Williams & Co., Buffalo, N.Y.

Metallurgical trainee, Wright Aeronautical Corp., Paterson, N.J.: **Herman H. Hanink**, University of Michigan '38.

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"Aerocarb A," the activating component, and "Aerocarb B," the bath component, are employed to obtain constant chemical balance in the bath. This assures the utmost uniformity in case penetration and hardness and economy in operation.

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These new Aerocarb Carburizing Compounds are made by the makers of Aerocase—the standard by which all case-hardening compounds are judged. Within the scope of the two steel-treating methods, every case hardening problem can be solved. Our engineers will gladly advise which is best for your needs.

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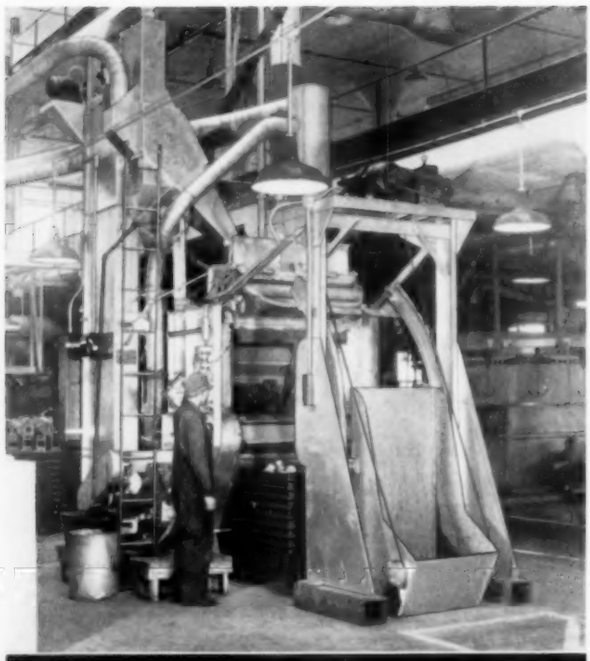

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The AMERICAN FOUNDRY EQUIPMENT CO.
511 S. BYRKIT ST., MISHAWAKA, IND.

Aircraft alloys

(Continued from page 670) cold on quenched metal, but they are preferably done hot; a final operation of quenching then gives the highest qualities to the material. Autogenous welding is quite convenient, but the strength of the welded joint is definitely inferior to the base metal.

It appears that aluminum-magnesium alloys may be improved by some additions (notably of titanium) even in very small proportions. These improved alloys have not been developed, however, beyond the laboratory scale.

Weldable light alloys with good resistance to sea water greatly facilitate the task of the designers, but the alloys which satisfy these requirements have properties much inferior to the better known light alloys. The designer willingly accepts the new advantages, but is not willing to "pay" for them by sacrificing the high properties.

From the viewpoint of electric welding, the aluminum-magnesium alloys have a marked advantage over duralumin. The metal altered by welding can have its structure restored by heat treatment. In this way one can hope to obtain a more uniform structure in the complete assembly, and increase the individual mechanical strength of each point, as well as the resistance to dynamic stresses.

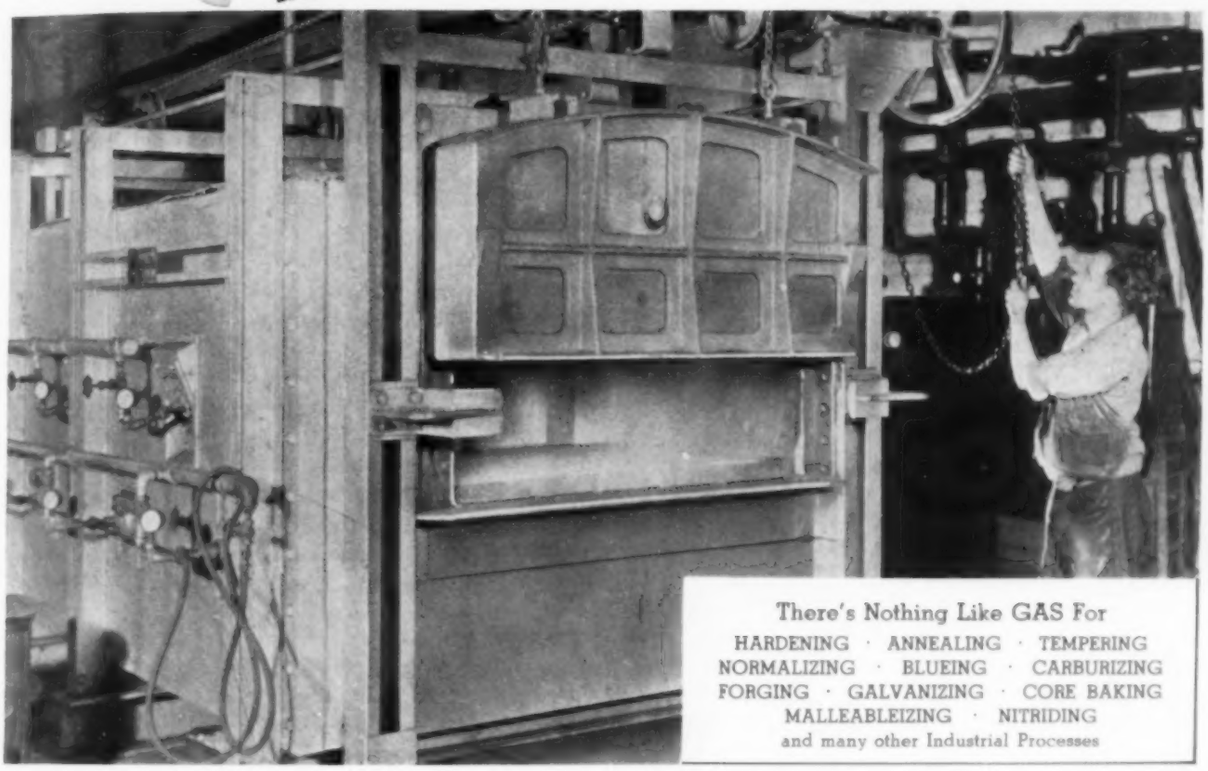
The placing of large assemblies of light alloys in a heating chamber has always been avoided, because a long time at 300° F. or higher involves a general lowering of the mechanical properties. Use of lacquers, particularly hot-polymerized bakelite resins, has therefore been impossible. This danger does not exist for the aluminum-magnesium alloys of low magnesium content. In the stronger alloys of 8% magnesium, however, a fragile zone exists between 300 and 650° F. Industrially, the two operations, heat treatment of the assembly and baking after protection, could be effected simultaneously.

Difficulties with the aluminum-magnesium alloys when subjected to a combination of fluctuating stresses and corrosion have emphasized the problem of auto-protection — that is, the rapid production of a very thin though adherent and elastic film, impermeable to the corroding element. Its velocity of re-formation at fracture has a definite bearing on corrosion fatigue. Accelerated corrosion, and such corrosion may be very large indeed, near places where another metal must be joined — as for instance a steel shoe on a pontoon — may be avoided by spraying the region with a less noble metal, like zinc or cadmium, which will offer protection by sacrificial action.

In the discussion, C. H. Desch pointed out that the possibility of obtaining the light alloys with a very great inherent *(Continued on page 722)*

Gas ALSO TEMPERS THE COST OF TREATED METALS

Modern, GAS-fired furnace de luxe in use at New York City plant of R. Hoe & Company.



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High in heat value, and capable of precise control, GAS produces perfect furnace conditions that result in a better product at materially reduced cost.

With modern GAS equipment, the combustion mixture is regulated automatically to synchronize with load demands . . . the heat is evenly diffused to produce uniformly perfect results and reduce losses from spoilage . . . work is speeded and furnace maintenance is brought to an absolute minimum.

Shown here is a modern, multi-duty, GAS-fired furnace with automatic temperature control ranging from 900 to 1,800 degrees F. It is equipped for economical heat treating of ferrous and non-ferrous metals, and is ideal for exacting factory work.

Investigate how GAS can temper the cost of treating metals in your plant!

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INDUSTRIAL GAS SECTION
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Contributors' page

A Note About the Cover

Acknowledgments for the front cover are various: To Bernard Collitt ⊜, metallurgist of Jenkins Bros. Ltd., Montreal, who suggested its use; to Richard B. Pilcher, registrar and secretary of the Institute of Chemistry of Great Britain and Ireland for the loan of the 300-year old engraving; to W. F. Sedgwick, Ltd. of London for the fine copper plate etching, skillfully hand tooled, from which the cover was printed; to F. Charles Thum of Paris for the border design and lettering, inspired by a medieval manuscript.

The original is one of a set of 20 plates entitled "Nova Reperta", illustrating the most important discoveries of the middle ages, engraved by Phillipp Galle from designs painted or sketched by Jan van der Straet (Joan. Stradanus). The work was done in Antwerp about 1600; engraver and painter were both Flemish artists of note. The subjects were so popular that Galle's grandson re-engraved the worn plates for further printings (and substituted his own signature, the crook!).

Mr. Collitt, on inspecting the proofs of the cover, wrote: "I am disappointed to notice that, in squaring up the engraving, the treadmill at the left side has been largely eliminated, together with the poor wretch in it furnishing the power for the blast. In the foreground the cleaners are at work with hammer and chisel just as they were 40 years ago. From a side-fired reverberatory furnace metal is flowing into a mold, singularly free from smoke. Up to very recently I regarded this picture as that of a bronze foundry, but I have learned that cannon were cast of gray iron in 1377 at Erfurt in Thuringia, and that in 1543 an English iron founder had an interview with Henry VIII and made a formal tender to supply all the King's cannon and grenades at ten shillings a hundredweight. So now I am wondering whether this bronze foundry is an iron foundry!"

A few prints were made from the engraving before it was cut down for the cover, and these will be sent gratis, as long as they last, to ⊜ members who write for them.

⊜ ⊜ ⊜

Worcester Polytechnic Institute graduated **W. A. Darrah** in the class of 1908. Starting out in the research laboratories of Western Electric Co., he soon became manager of engineering of rectifiers, regulators, lighting and related operations in the Pittsburgh plant. With a flair for management problems added to his technical knowledge and skill, he then spent three years as manager of engineering of Ohio Brass Co., and during the War was manager of operations at Noble Electric Steel Co. in California. In 1919 he organized and became president of Continental Industrial Engineers, in which capacity he acts as co-author of the description of the carburizing furnace built by his firm (page 678).

⊜ ⊜ ⊜

The other two authors of this article on a gas carburizing furnace without a muffle are the men who have most to do with its operation in the plant of Chevrolet-Muncie Division, General Motors Corp. **Wilbur E. Sanders,** plant engineer, has had 20 years of plant, processing and construction engineering experience. **J. L. Coyle,** research engineer, has been with Chevrolet for the past seven

Henry C. Bigge

Wilbur E. Sanders

Louis J. Larson

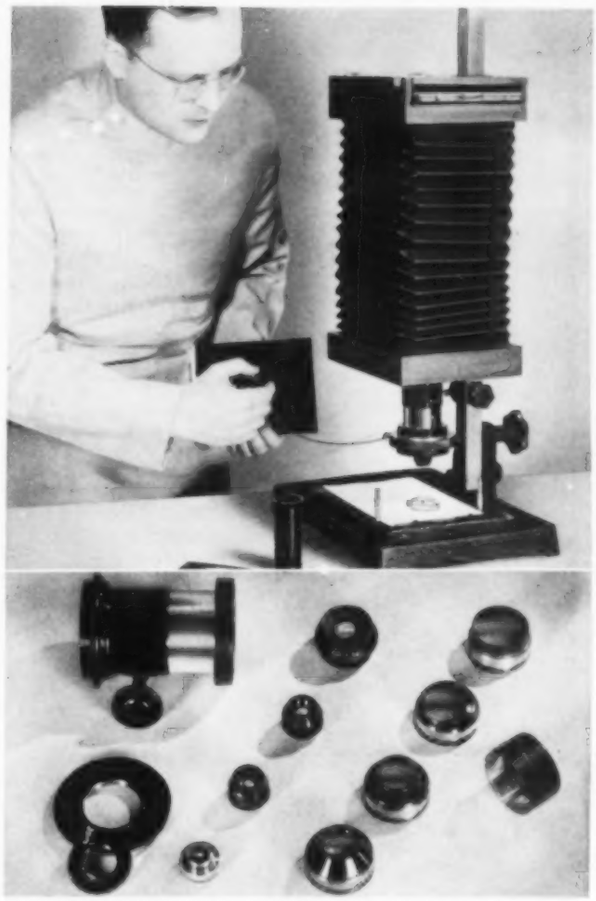
Federico Giclitti

years in the laboratory, maintenance, power plant and heat treating departments. He received his B.S. in mechanical engineering from Purdue in 1935.

The first nine years of **Louis J. Larson's** career were devoted mainly to mechanics and teaching. With a B.S. in C.E. from University of Minnesota and a year as research fellow at University of Illinois, he started his first full-time job as laboratory assistant and assistant engineer-physicist at U.S. Bureau of Standards in 1917. From 1920 to 1926 he taught mechanics, strength of materials and hydraulics at University of Illinois. In 1926 he joined A. O. Smith Corp. in Milwaukee as engineer in charge of research and development in arc and spot welding. His work with this pioneering and successful firm has been quite varied. Some of it has been of a fundamental nature to determine what actually takes place in the metallic arc during the welding operation. Other phases have been directed to the solution of production problems. His studies of welding technique and proper equipment, both manual and automatic, have resulted in numerous patents and publications.

Among the top-ranking contributors to **Metal Progress's** foreign letters department is **Federico Giolitti**, dean of Italian metallurgists, who lists five companies of which he is now president and then adds an "etc." Receiving a Ph.D. from University of Rome in 1902, Dr. Giolitti spent the next three years in Germany. He then returned to Italy to teach metallurgy and metallography at University of Rome and at the Royal Engineering School of Turin. From 1912 on through the War he was general manager of Ansaldo Steel Works in Genoa (the principal armament and machinery firm in the country). Resigning from this position about 15 years ago he became consulting engineer for various Italian enterprises, general director of Cogne Steel Works in Aosta, and finally president of a list of companies that includes steel plants, tool manufacturers and an aluminum company. He is the author of 130 technical papers and of three books. His letters to **Metal Progress** have been arriving regularly since its inception in 1930.

Henry Christian Bigge attended Carnegie Institute of Technology, worked for Crucible Steel Co. of America, for Carpenter Steel Co. and finally for Bethlehem, where he has been superintendent of electric furnace and toolsteel departments since 1918. In this issue he tells about forging and rolling of toolsteels. Details of inspection, testing and finishing will be covered in the concluding article of the series.



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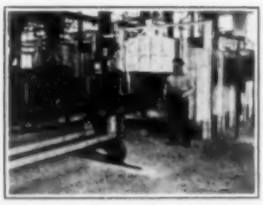

4] Roller Rail Tube Annealing Furnaces. 237 K.W. in three zones.

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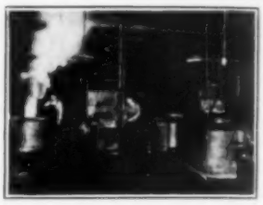

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EDITED BY [illegible] PRESIDENT

ALLOY PROGRESS

Bright Spot in Metal Progress

GREETINGS, New Year!—You start young, eager and promising but you will be crammed full of politics and hypocrisy; become the battleground of class warfare.

DOWN your days will march lice and lords, the quick and the dead, our brothers and our brother's keepers, the self-anointed, the unanointed, and the appointees.

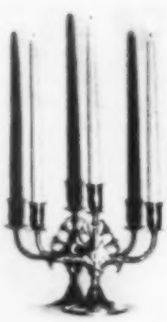
THIS child will be taught to measure human progress in terms of battles, political regimes and geographical alterations. He may never realize that improvement in creature comforts, added leisure, education, are gifts of science, and industry, not politics.

AMERICAN business will work out of this new federal depression if the mischievous fools who have shackled it can find the keys and remove the manacles. Else like Samson it may destroy the temple. That would leave the flees without their dog.

IF each of us can make one genuine contribution to the arts in which we work, progress will follow.

LET'S do our part to give this youngster, 1938, a decent chance.

[signature]



P.S. Three candles burn brightly to our three "gods" who reward the living and place a mark of measure upon the dead:—Loyalty, Mentality, and Vitality.

Note: 1 - Upper photograph is New York Stock Exchange.
2 - U.S. Sub-Treasury, Corner Broad and Wall Streets.
3 - U.S. Steel Co., 71 Broadway.

NO FURNACE IS BETTER THAN ITS ALLOY PARTS

THE dog's name is "Fly" and the cat is "Sitting Bull." They belong to the Charles Hough family and I snapped them at Lawsonia, Wis., which has a swell lake and a lousy airport.

WELL, our jolly little strike is over, and most of the boys are back on the job, wiser and broke. A decent, orderly bunch who struck the wrong shop at the wrong time. They had no grievances, just asked for a 20% increase with foundry activity in the districts about 30%, layoffs increasing, temperature dropping and relief rolls swelling.

THE strike caused us little serious difficulty. We operated steadily, found plenty of men available and had 400% reserve labor supply lined up when the strike ended. General Alloys supplies the steadiest foundry employment in this territory. We considered wage increases in these times entirely out of order. What they got they owe to James Moriarity, Massachusetts Commissioner of Labor. Because James Moriarity, a former labor leader, but a straight shooting American, has the respect of industry as well as labor, several large industries are moving to Massachusetts from states where politics are sabotizing America for votes. Commissioner Moriarity has turned the tide, is bringing jobs back into a state from which labor racketeering has chased many plants. Firestone is opening a new Massachusetts plant and General Motors may follow.

READERS asked if "Chet" (Chester Swanson, I.M.U. organizer) accepted my challenge to debate the strike issues, on the platform of the Union Hall. *He did not.* Presenting both sides to the men, who I am sure would have given me a fair hearing, might make them think. Facts have small place in strike psychology. Minor details like the surplus of available labor, impending winter, reduced production, are ignored. Men generally strike on a full belly against a shop that has been giving them steady employment. (The [illegible] wouldn't play ball on that Thanksgiving turkey either.)

NOBODY ever "Won" any strike. Strikes are very expensive to [illegible] concerned; most of all to the men who strike with their measly "Benefits" that don't start 'til the second week and from which back dues are deducted. The constitution of the International Molders Union states "Whereas, Our own experience, and the experience of all labor organizations, has taught us that while the strike as a weapon of defense cannot be abandoned, it has long been apparent that as a means of adjusting grievances it is not the most satisfactory, while on the other hand it is the most expensive."

WE had some "comedy relief," such as a committee member and the toughest agitator returning to work during strike. Granite blocks dropped from a bridge on a G.I. truck, fortunately missed the driver.

IF anybody could sell me the idea that I could better myself permanently by striking, I'd strike.

MOST of our men did what they thought was right. Some were intimidated, others don't know why they went out. They have returned in fine spirit, are doing an excellent job and we are glad to have them back. General Alloys continues an open shop where a Union man can get a square deal. Our customers provide the work for General Alloys workmen. I am only an intermediary,—a kind of necessary evil on the crossroads of commerce. Seriously, I think our strike did us all a lot of good. We understand each other better and we are going to make better alloy, sell more of it, make more profits and pay higher wages,—God and Government willing. A month's pay is a high price to find out that the boss doesn't give a damn whether you strike or not and a dozen men want your job.

THE FOOTPRINTS OF GENERAL ALLOYS
GA X-ITE
Q'ALLOYS
GA
Q'ALLOYS
GA X-IT

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A FRIEND, now represents us in INDIANAPOLIS & MUNCIE, IND.

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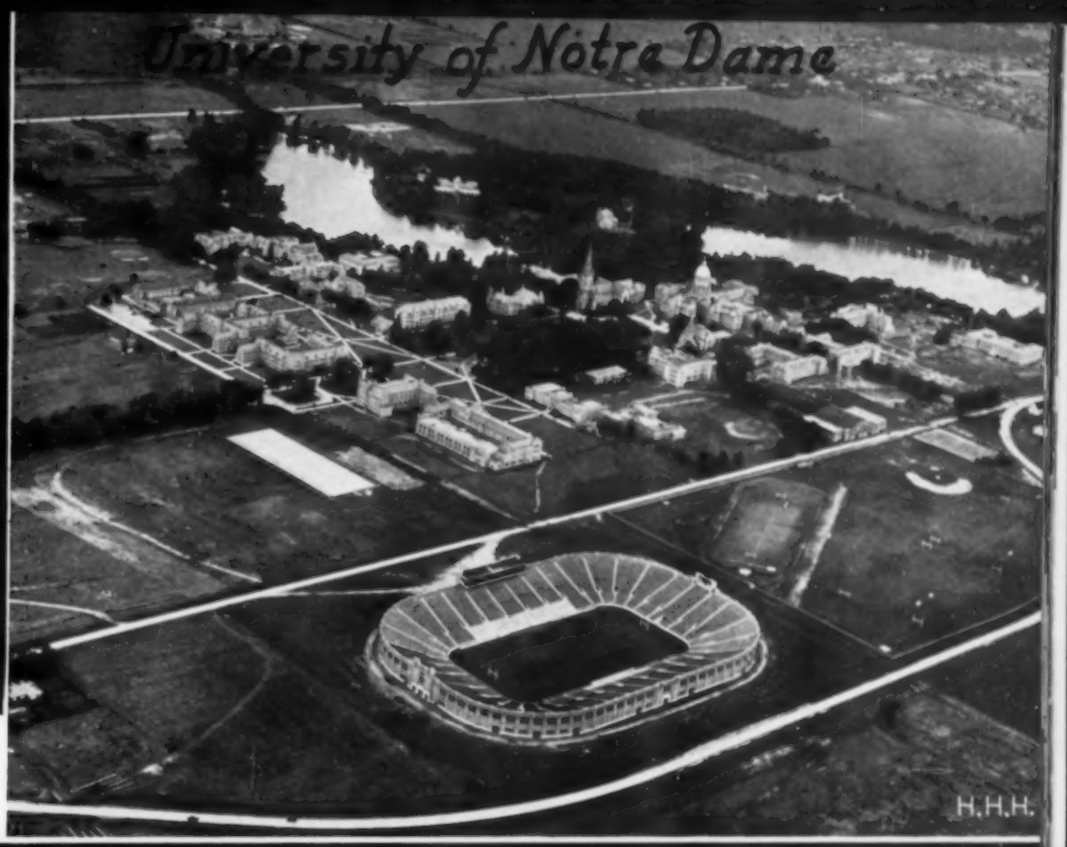
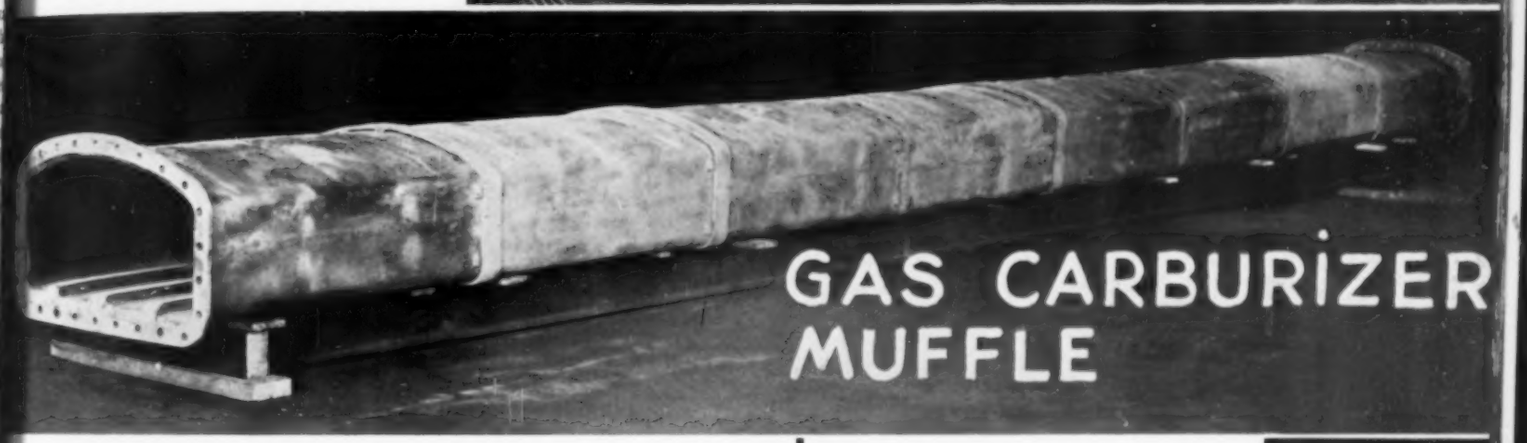
Hit 'em low
Q-Alloys
Let's go." G. O. D.





GAS CARBURIZER MUFFLE

WE are proudly happy to announce the appointment of The George O. Desautels Company of Indianapolis and Muncie as General Alloys representative in central Indiana.

GEORGE is an old friend of long standing, is well known to all steel treaters, one of the founders of A.S.S.T., is an outstanding drop forge man and Indiana's best salesman.

GEORGE served his time as a die and tool maker with the Paige & Storms Drop Forge Company at Chicopee Falls, Mass. After spending 25 years in the drop forge industry in the forging and heat treating of steels, he has spent the last 15 years in sales engineering, handling machinery, machine tools, heat treating accessories and equipment.

THE Desautels organization consists of three engineering salesmen, all with manufacturing background, and an office personnel of four. Office layout and facilities are second to none anywhere. Other accounts handled by George O. Desautels include Heppenstall Company, American Broach & Machine, Erie Foundry, National Tool, Ex-Cell-O Chemical, and the Amplex Division of Chrysler Corporation.

"THROUGH the outstanding quality, and leadership of General Alloys plus the numerous merits of the hinged tray, the Spiratube and Q-Alloy and X-ite products generally, there will be little real competition for General Alloys in Indiana," says George.

GEORGE DESAUTELS' outstanding moral and financial responsibility, his record of achievement in manufacturing, engineering and sales fields is widely recognized. In his connection with General Alloys, the *number one* alloy company gets the *number one* Indiana representative and the customers get *A-1 service.*

IF you have a plant in Kokomo, New Castle, Anderson, Indianapolis or Muncie, ask George for an aerial photograph of it. I shot about 500 Indiana shots recently, several of which have appeared in the Indianapolis rotogravure section.

THE Notre Dame football factory is a nice piece of real estate. Count the football fields. We slipped up last month and forgot to label the University of Michigan at Ann Arbor. If you are an A.S.M. member and you attended either the University of Notre Dame or the University of Michigan, we will be glad to send you an enlargement of my aerial photograph with our compliments.

MY New York pictures on page 1 are a better testimonal to the reliability of my Warner engine and Fairchild airplane than I can write. (These pictures and others appear as covers of *Financial World.*) Our fair and simple request of you is that you send us your inquiries for heat and corrosion resisting alloys. Nothing could be more logical than to send such inquiries to the oldest and largest exclusive manufacturers of these products. If you attended the Chemical Show

(Continued on following page)

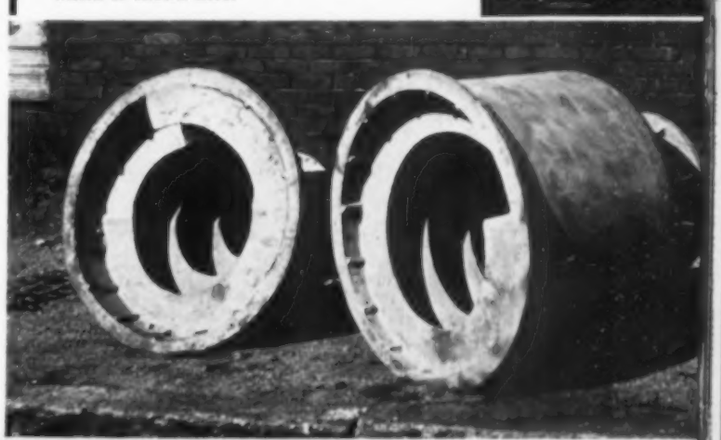
RETORTS AND MUFFLES

GAS carburizer muffles get much more severe service than any carburizing box, are a lot trickier to make and cause a lot more grief when they go bad. Discerning manufacturers who buy gas carburizing furnaces specify General Alloys retorts and save a lot of headaches. The largest and longest carburizing muffles ever built are General Alloys and two of them are being shipped as this is written.

THE usual gas carburizing retort is simple as casting lead soldiers compared to General Alloys internal spiral retorts, one of which is shown here.

"There is NO SUBSTITUTE for EXPERIENCE"

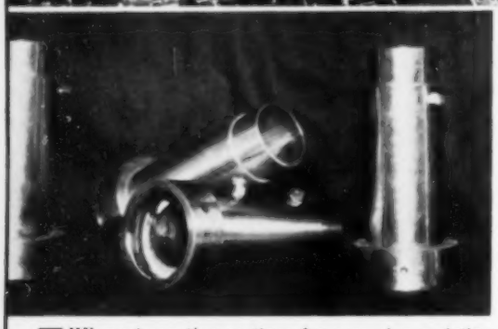
and no alloy experience to compare with G. A.



BECOME THE PATH OF AN INDUSTRY

GA Q-ALLOYS GA X-ITE GA Q-ALLOYS GA X-I

Q-ALLOY
STAND UP UNDER FIRE



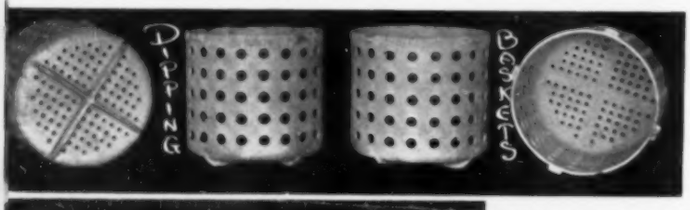
THE most exacting castings for corrosion resisting applications are those which must be machined all over, free from pits and imperfections. The nozzles illustrated here are most unusual. Exceeding U. S. Navy specifications, C.R.S. No. 46S27a, these Q-Alloy CN1 castings machine readily, tap easily. Dipping baskets in great variety are made from Q-Alloys. Hundreds of types of thin cast baskets, sheet baskets, wire baskets and cast frame baskets with perforated or slotted sheet sides, are only a few types. If you use dipping baskets, write us.

ENGINEERED ALLOYS
NEW ITEMS OF INTEREST

AMONG the H.H.H. Patents allowed in December is one on a process for darkening stainless steel, permitting a range of finish from solid black or green to the slightest dulling of the polished surface. It is done with dots, like a half-tone, of metal deposited to form any pattern or shading desired. The dots are small areas physically, break up electrolysis, are visually continuous.

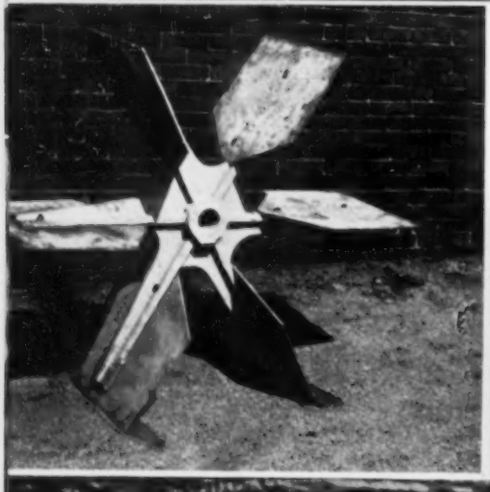
OUR new spiral combustion tubes will be released shortly. Having greater area inside and out, they transmit more heat, control turbulence, permit the hot gases to wipe the "insulating dead gas layer from the inner wall by rotative action without increasing the rate of flow *through* the tube." They can't be made on any of those "centrifugal casting machines," with which a French baker's dozen of alloy founders are trailing the cast iron sewer pipe industry by twenty years. Consequently they will have reasonable uniformity, not a 400% difference in grain size between inner and outer surfaces.

MOVING loads up to 1000 lbs. per sq. ft. in a continuous furnace of any length or width desired becomes no problem at all with a new type of mechanism called SPIRALINK SENIOR.



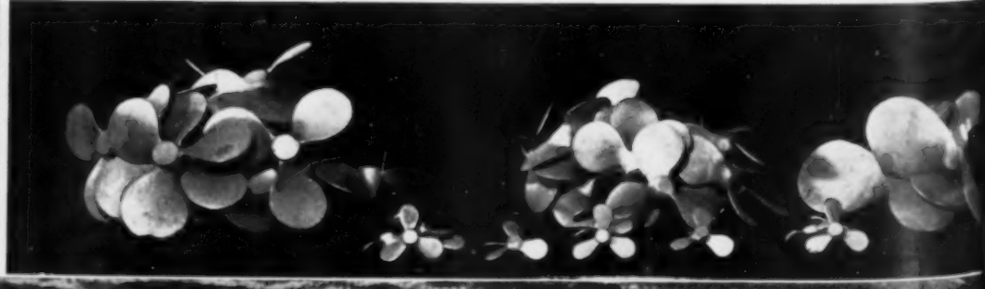
IF anybody offers you a collection of slats as a substitute for a hinged pusher furnace tray, start laughing.

GEORGE McCORMICK designed a corking basket type tray for malleableizing, the sides of which are permitted to move, as the charge grows and expands, by the burning of small wooden plugs.



HUNDREDS of high temperature and high speed fans of open and closed impeller types, single and double stage and "squirrel cage" types have been made by G.A. for temperatures up to 2200 degrees and speeds up to 3500 r.p.m. If you use fans at high temperature and want them to stay together and run —specify General Alloys.

PATENTS and claims regarding the use of "Grindstone" hot bearings to support conveyor rollers inside furnaces continue to amuse us, as we reduced this to practice, advertised it in *Transactions* years before its "Invention." Roller bearings, self-aligning G-S bearings and pressure equalizing bearings for high temperature operation are new G.A. developments.



(Continued from preceding page)

In New York, you saw an outstanding Gen... loys exhibit. Attend the Motor Boat Sh... General Alloys exhibit of America's finest ... products in polished Sea Steel castings.

WE appreciate the many nice letter... lady readers. We still have a few ... bean slicers left,—one for each lady who ... the "editor" her comment on Alloy Prog...

JANUARY 29 is the 250th anniversary ... birth of Emanuel Swedenberg, fa... modern metallurgy.

AS Superintendent of Mines for the ... Government, Swedenberg laid the f... for our modern metallurgy of both iron and ... per. His books are corner stones of ... cal literature. (The family name was or... Swedberg.) His father, Bishop Swedber... the first Lutheran Bishop of the Swedish ... of America, including Delaware. A cousin, ... Svedberg, won the Nobel Prize for the ... centrifuge. (1,000,000-X gravity.) If our "... lurgical press" is sufficiently wide awa... properly honor Swedenberg on his 250th ... versary, I will be surprised.

ANOTHER famous Swede, International ... vester's famed "Swedish Ambassador ... Germany," Mr. Nels Nilson, has finished ... in showing the Nazis how to heat treat ... course, has told them about those better ... boxes and hinged trays. He is on his way ... to tractor works.

A DOZEN times, I have passed over U. S. ... Plants at Gary, Indiana, sometimes above ... clouds and again low enough to get slag on ... wings. It is a smoky, dirty place and I ... get it all in my camera under 7,000 feet. ... tures of buildings are not sharp from one ... mile away. Try and beat it.

DECENCY in journalism. "In view of the ... sire of the Lindberghs for privacy, the ... *Herald* prints no photographs, eliminates all ... necessary stories theorizing on their visits." ... *Boston Herald*.

MASSACHUSETTS is trying a new scheme ... in handling traffic, one of praise for ... ful driving instead of mere condemnation ... reckless driving. A medal was awarded ... Walter Fasnell, who jumped a ditch to ... running down pedestrians, and to Ed... O'Hoolahan, truck driver, who pulled up ... avoid a child, and messed himself up.

GIFT shop salesman corners Mrs. H. and ... on heated argument for electric clip ... "Nix," said the Mrs., "my husband has ... kidding me for two years over one of ... gadgets which he says are built for tickling ... lescents and not clipping beards." "Well," ... the salesman, "bring in the old man and ... shave him." Which means I have something ... look forward to.

WHEN you hear about new fangled cardboard ... ing boxes with loose top and bottom, ... forget the *original* General Alloys "cast ... sheet box," which is made of heavily corrugated ... wide walls, the corners cast round them, ... welding, maximum heating rate and the longest ... life records of any large box installation in ... tory. Thousands of them running 1200 to ... hours. If you want heat treating containers ... any kind, General Alloys leads the parade.

GENERAL ALLOYS COMPANY

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CHAMPAIGN, ILL.

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80 E. Jackson Blvd.

PHILADELPHIA
W. T. Fitzpatrick
400 Morris Bldg.

DETROIT
4-137 Gen. Motors Bldg.

INDIANAPOLIS
Geo. O. Desautels Co.
Postal Sta. Bldg.

ST. LOUIS
Randolph Whitman
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PITTSBURGH
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FREMONT, O.
M. K. Brown
Memorial Park

LOS ANGELES
Allan Arnold
[illegible] N. Ridgewood

OLDEST AND LARGEST EXCLUSIVE MANUFACTURER OF HEAT & CORROSION RESISTANT ALLOYS

HOUSE ORGAN OF O'ALLOYS To Be Alloy GENERAL ALLOYS COMPANY

EDITED BY [illegible] PRESIDENT

ALLOY PROGRESS

Bright Spot in Metal Progress

MINNIE MOUSE PELICANS—

WALT DISNEY, having Farleyed Mickey Mouse into the incandescent spot of celluloid celebrity, has piqued contemporary mice no end. As Chinan Porters have been acquitted of assault when persons addressing them as "George," so real mice righteously resent being called "Mickey" or "Minnie." The "Minnies" are particularly indignant—they resent the insinuation of big feet.

THIS little lady was born in the decanting tanks in No. 4 Wine Hold of l'Hirondelle, Royal Yacht of Albert, Prince de Monaco, first saw the Mediterranean sky through teak gratings and scampered to the popping corks. Rodents stole upon her, so successfully that her seven sons and four daughters nuzzled greedily when she arrived in my office as a stowaway in the German Ex-Kaiser's House Flag, removed from l'Hirondelle when I sold her. Then, adding insult to injury, she was dubbed "Minnie."

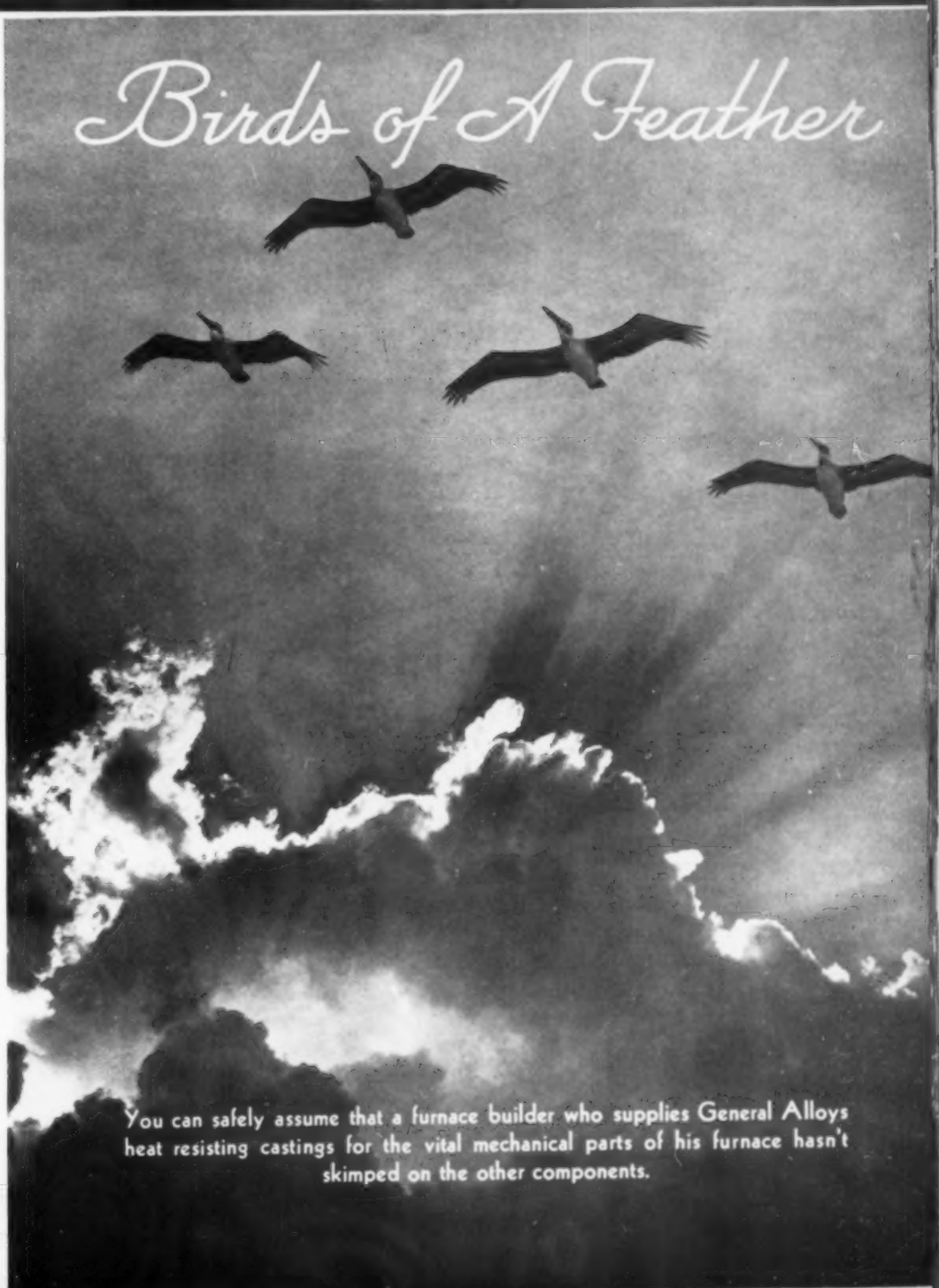
LOOK closely, to find Minnie in the center of Alloy Progress on my desk in above picture. For those who forgot their glasses, here's a picture of Minnie asleep after a good meal on page two. She snores and wakes herself. Minnie, linearily, is 59.376% tail.

THE feathered foursome arising at the crack of dawn are those Pelicans, whose beaks hold more than their bellys can. Their lunch boxes are their chins up.

THIS "birds of a feather flock together" line reminds us that no furnace is better than its alloy parts. Speaking of furnaces, don't let anybody sell you any pusher-tray furnace that can't use hinged trays in and save approximately 40% in tray costs, often enough to pay for the furnace in a few years.

The next Bull Market

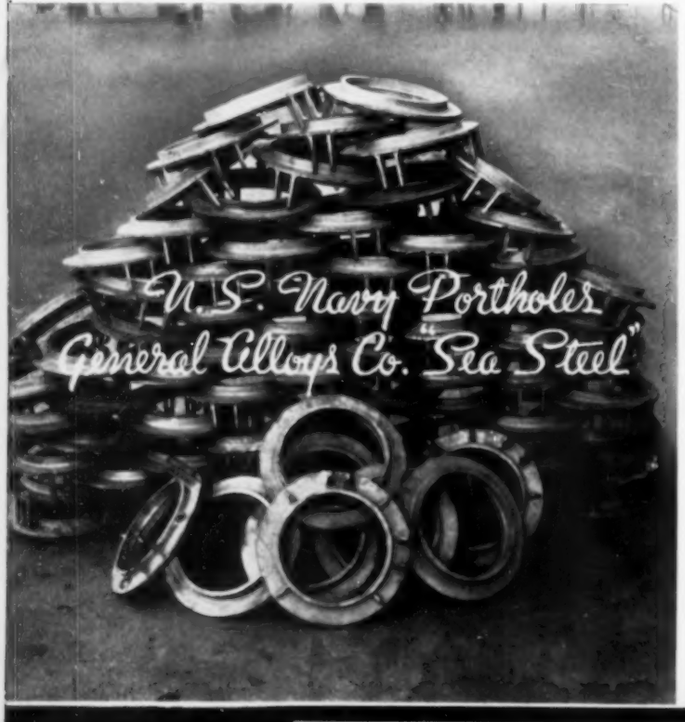
WE predict a Bull Market. But we can't say when. Maybe it will be in Heaven. Just ride a damp cloud and a dry harp and climb aboard. But don't sell General Alloys short.


Birds of A Feather
You can safely assume that a furnace builder who supplies General Alloys heat resisting castings for the vital mechanical parts of his furnace hasn't skimped on the other components.

O'ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite

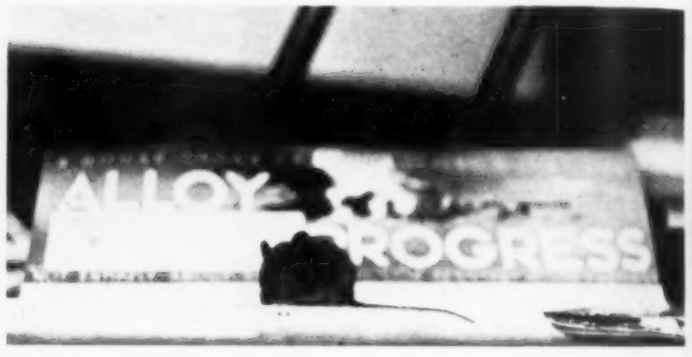
NO FURNACE IS BETTER THAN ITS ALLOY PARTS

PHILADELPHIA Drying Machinery Company, Philadelphia, Pa., built the above Spiralink conveyor hearth furnace incorporating unusual features of tension take up, discharge direct to quench, etc. Write them for their new catalogue on small standard furnaces.



RUBBER-LIKE water is substantially incompressible, you *distort* it but you don't *compress* it. Rubber automobile "springs," developed by Noble and Harris, form the basis of new street car developments and will eventually appear on production automobiles. The lifting of automobile valves on a column of oil, "hydraulic clearance adjustment," now standard in leading makes of automobiles, is another N & H contribution.

ORDINARILY, Albert Einst and I do not agree in our sel tion of spare-time reading. It therefore, with genuine enthusi that I note his splendid endorse of Viscount Samuel's new book, "P lief and Action." The force of



MEET my friend, Octave Van Buren Branham, brunette disciple of loyalty, optimism and service. "Doc," for short, has faithfully served three generations of Houghs, and is high priest of the Hough hospitality. His incomparable cooking, expands my midriff, causing me a Turkish bath on each visit to Chicago, but it's worth it.

CHARLES HOUGH, who plays "Robinson Crusoe" to Doc's "Friday" is a General Alloys director, a prominent Chicago attorney and has done much to improve ethics of the legal profession, promote Sigma Chi, strafe the Von Hindenburg line and wreck the Plaza Hotel at Havana. His father was my stork. His children give me faith in the future, politics not withstanding.

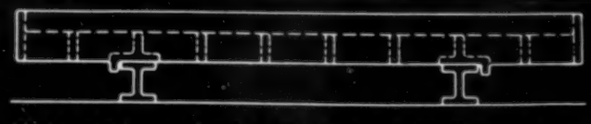
I SENT "Doc" prints of the above picture before Christmas. He wrote, "You fixt my Christmas shopson in tones of hope and cour speaks eloquently from these pa A statesman and practical man affairs, Samuel has done a great ser ice in expounding a rich and th oughly modern philosophy. It good meat if you are tired of su frivolous stuff as Alloy Progress.

MR. E. H. Spencer, superinten ent of a well-known Roches heat treating department, has be testing Q-Alloy against pressed st pots in identical Steward gas-fir pot furnaces. "The Q-Alloy pot h run more than a year and still loo O.K. It cost $65.00, including pattern charge. During the sa period of time, we have used pressed steel pots at $9.00 eac Add to this costs of shut-downs, leakage and handling in figur Q-Alloy savings.

MRS. Ben Jones had Ben arres for drunken driving in Ric mond, California. Driving his c

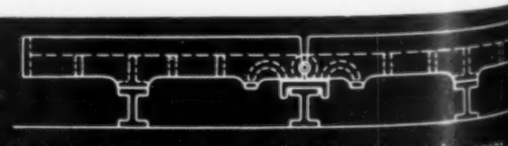
CHECK THESE SAVINGS

1



If this rigid tray for two rails weighs 100 lbs.—*then*—

2



This single hinge tray for same job will weigh appro

12504

INTERNATIONAL

LLIS-CHALMERS

ran head-on into her driving her car. th are on WPA. It's great that we tax-rs can keep these two-car families in style to which they are accustomed.

E slipped up badly in the last A. P. giving heat-hour-service on Q-Alloy corner sheet boxes at "1200 to 1400 s." It should have read 12,000 to 00 hours.

T The Steel Show in Atlantic City, Rufe Tucker bet John Heckman five rs that Princeton would beat Yale. Keener held the stakes. Several later, after Yale had beaten Prince-Rufe Tucker received a note from reading, "You are the winner on a for which I held stakes. Herewith check for $20.00."

IMMY DOOLITTLE was flight test-ing an army pursuit ship. At a 0-ft. power dive approaching 400 s an hour, the wings blew off. Jimmy reporting all events and instrumental dings by radio and continued to re-

(Continued on next page)

HARRISVILLE, ILL.

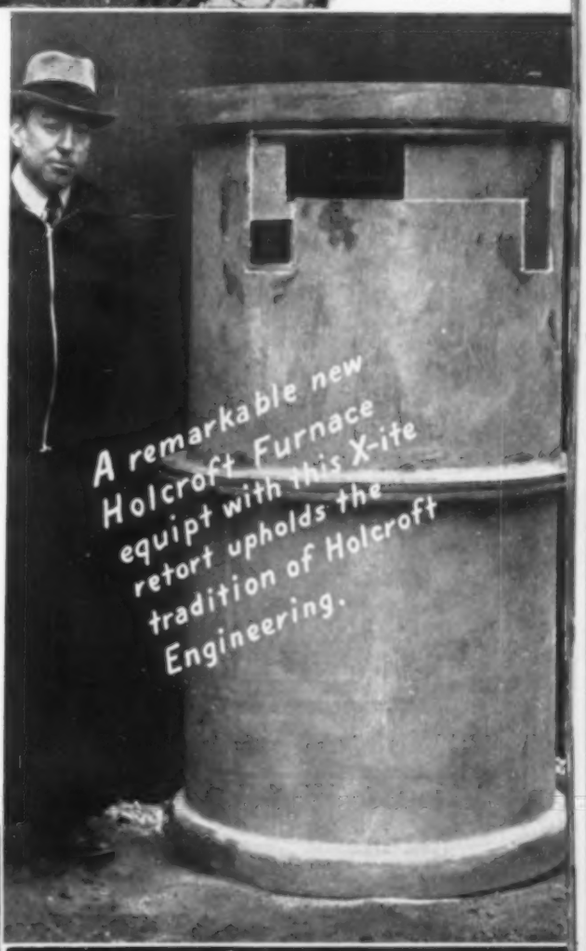
THE ORGAN PLAYS
In Harrisville's Church

THE organ plays in Harrisville's church. Good craftsmanship is its own reward.

"HARRISVILLE"
Is a Model Village of 200 People!

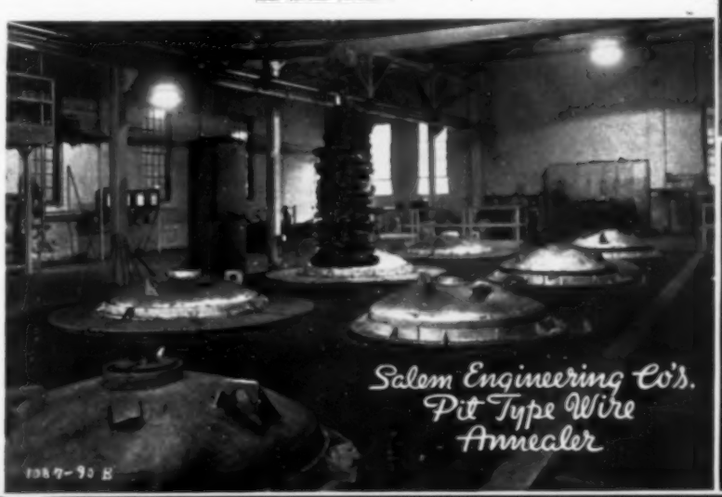
BUILT by B. F. Harris for his sons, B. F. and John, this model job is "tops" in its class. From manhole covers to clothes pins on the wash line it's complete. The business district shown has such detail as a church organ which plays, ringing bells in the belfry, fire alarm system, running water and complete, modern traffic control. The residential section, country club and alloy plant are being completed. B. F. H., brother of H. H. H., built our G. A. Model furnaces and is an industrial designer with offices in Chicago. This job has it over the miniature equipment offered by the toy railroad builders like General alloys has it over steel foundries philandering in the alloy business.

CAUGHT in the act. C. K. Kuhne, Manager of the Gulf Engineering Company of Houston and New Orleans, gets all set to run for a beer on Junior's bike when the Christmas Kodak clicks.



standing Progress in
rnace Engineering

s is written, General Alloys orders for furnace parts for new furnaces. All these with four exceptions, are proved in combustion, ma-rial and general engineer-of similar furnaces of three Take stock of your old and call in your furnace We're telling you, new, furnaces will pay for them-so fast you can't afford to lag about them.



Don't buy any "Pusher" Furnace without consulting GA on Hinged Tray Savings!

twin hinge 4-rail tray will weigh approximately 60 lbs.

4

A three hinge 5-rail tray will weigh approximately 48 lbs.

THE SAVING IS OBVIOUS

port for an
tional 5,000
wingless
Many were
ing in. Finally, before leaning
parachute, Jimmy spoke into the
phone. "Okay, God, you take over
here. I've done my stuff."

A FRIEND of ours wrote from
many, "When I first saw
boxes, I thought of you at our first
ing sixteen years ago; we had some
much the same." He referred to
crude cast iron carburizing boxes

WHY BE A MISSIONARY?

The Missionary's life is hard. He gets small pay, little thanks and great risks. Maybe he ends "in the soup."

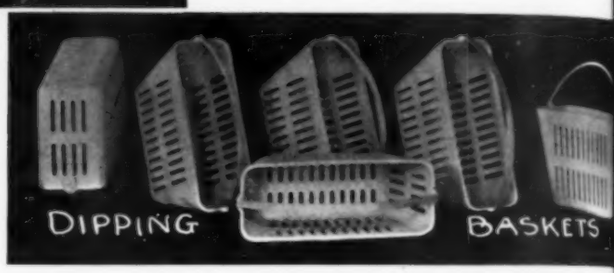
"Carrying the Torch" for a worthy cause has its moments, when a meal-ticket goes with it,— but lugging along a couple of spare "Torches," without pay, merely increases the burden, slows the pace, and makes you a better target.

Why should any furnace salesman be a "Missionary" for some second string alloy manufacturer, sponsoring inferior alloy, as part of his furnace, to outstanding concerns who buy Q-Alloys and Xite for their own direct purchases? Isn't it tough enough to sell a furnace with GOOD ALLOY?

We doubt if the few pennies "Saved" on "Cheap" alloy pays the missionary cost, and we know that the "Converts" often put the "Missionary" in hot water.

H. H. H.

IF you do any cyanide, salt or lead hardening or use baskets, hooks or fixtures of any kind, General Alloys can make them better.



tured herewith, in a large German industrial plant. American plants used them before Q-Alloys. Our European friends could well follow the example of leading American industrial plants in standardizing on Q-Alloy heat treating containers.

TRAVELING from Indianapolis to Muncie, we passed James Whitcomb Riley's birth place, photos herewith. Until you have read his "Ode to a Backhouse," and Benjamin Franklin's "Advice to Young Men," you have missed some of the humanity which made these men great.

RUBY SLOSSENFESSER, vacationing beautician, was knocked clear off her bunk, landing on her ample rotunda. A cloud of glass dust descended upon her. She had scratched one of those heat treated "strong as steel" glass portholes in her ship's stateroom "just to try her new diamond ring to see if it would cut glass." The scratch leased, the high surface ten "exploded" the glass.

THE name plates, numbers page 3, are "Kloizenay" made der H. H. H. patent for fusing gla color on stainless steel. Our first was the entrance plaques of Century of Progress at Chicago you want beautiful plaques or s specify "Kloizenay."

TAKING her flight tests in cago, Mrs. H. (weight 100 s. w.), was fitted with a mas army regulation parachute "alte to size by tying the straps up grocery string. The maker shifted in a tail spin, permitting straps to fall over the stick and it into a back position. It took seven turns of tailspins to slip harness, get it off the stick and out for a good landing. Didya try it?

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SAN FRANCISCO
S. Craig Alexander
976 Clayton St.

FREMONT, O.
M. K. Brimfield
Memorial Parkway

LOS ANGELES
Allen Arnold
103 N. Ridgewood

OLDEST AND LARGEST EXCLUSIVE MANUFACTURER OF HEAT & CORROSION RESISTANT ALLO

OUSE ORGAN OF Q-ALLOYS To Be GENERAL ALLOYS COMPANY

ALLOY PROGRESS

EDITED BY H. E. Harris PRESIDENT

Bright Spot in Metal Progress

OBSOLESCENCE

Yours for Bigger and Better Ash Cans

I HAD my first ride in a "Stanley Steamer", cross between a tea-kettle and a perambulator, age three months. The benzine-buggy shown evidenced my Father's eleventh contribution to embryonic Detroit. This thunder-bucket had a "Junior" dickey seat on the rear door, which, jarring open, often plopped my tender stern on mud or gravel. It was agreed I could drive a car when I could crank one, age ten, and at fourteen I was dirt-track racing my own cars in the money.

YOU have seen the development of the automobile, and the airplane, which have employed so many, grown so rapidly largely because they become OBSOLETE LONG BEFORE THEY WEAR OUT.

BRAINS AND INITIATIVE add VALUE and SERVICE to cars and planes so fast that new models crowd the "Old" ones into the junk-yard while still in their mechanical prime. Village Bankers and great Economists deplored this "Terrific waste", condemned the buying of cars by the millions who "cannot afford them", held up as a Model of Thrift the man who wore his clothes, drove his cars, played his cards, until they fell apart.

SUCH thrift, whatever its moral value, would be economic suicide for U.S., if practiced widely.

OUR INDUSTRIAL FUTURE IS GEARED TO THE QUICK TURN-OVER. NEW MODELS, not Politicians, lead us out of depressions. On the drafting boards, in the laboratories, in chart-rooms of Industry a few men with the Vision, Guts, and Intelligence of Leadership are plotting to *CREATE MORE OBSOLESCENCE,—THAT AMERICA'S PARADE OF PROGRESS MAY MARCH ON.*

WHEN any article is junked by Style, or by functional or technical Obsolescence *before it is worn out* an *increment* of NEW EMPLOY-MENT IS CREATED that would otherwise be *lost.* Thus, EVERY PRODUCT WHICH LONG CONTINUES UNCHANGED IS BLOCKING EMPLOYMENT, PRODUCTION and PROGRESS.

ANALYZE *your* products *functionally.* How can you improve them? Is anything you are doing or selling the "Last word"? WHAT IS THE *NEXT WORD* and HOW CAN YOU SAY IT, *NOW*, to aid in recovery?

OF only ONE thing are we CERTAIN:—CONTINUED CHANGE. A "Crazy" Inventor is worth a thousand "Sane" Politicians. "Model T" could have "busted" Henry Ford in less years than it made him.

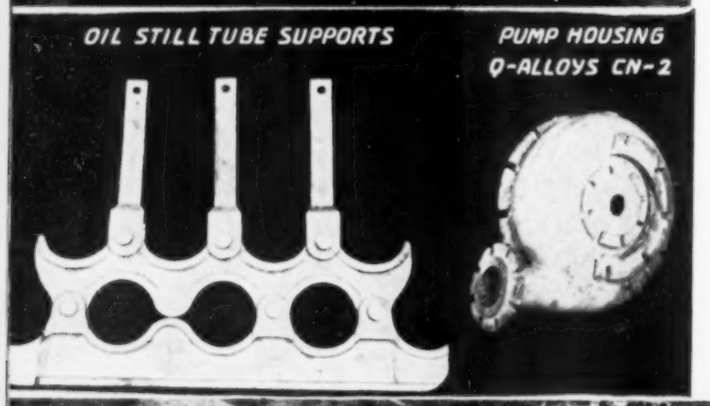
ONLY by creating NEW PRODUCTS, and NEW MARKETS, can we create NEW JOBS. We will only work out of depressions, and stay out of future depressions by increased employment, sustained production, accelerated OBSOLESCENCE. Take a tip from the Chem-ical Industries; spending 5% of total income on research, lead all industries through depression periods.

IF you have the brains to build a better mouse trap, do it now, or you will soon have to bait your old one with a much bigger piece of cheese.

H. E. Harris

FOUR GENERATIONS: H.H.H. with Father B.F.H. II—Grandfather H.H.H. and Great Grandfather B.F.H.

Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite



PLEASE,
who owns "NEP"?

WHO sent me the excellent action shot of this great little guy? It reached my desk unidentified. Dan & Roger, my Scotties, bark at this picture,—*it must be good.* Scotties are "*simply nutz*" about white dogs. If you've a canine pal, *send us his picture,* for our future "Dog Number."

BRAZIL, focal point of many cultures and technologies, moves forward sanely, progressively, in industry and education. Instituto de Pesquizas do Estado de Sao Paulo, outstanding technical school, will install a modern foundry, equipt with a one ton furnace, fully modern throughout, which will serve Brazil's industries by tackling their foundry problems full scale, licking tough problems, presenting solutions in commercially usable form.

MIGUEL SIEGEL, Chefe de Servico Scientifico, young, intelligent, practical and 100% business, is plugging away in coveralls in General Alloys foundry, learning, and giving us helpful suggestions. G. A.'s fame for "the world's finest foundry practice" has brought us visitors from France, England, Russia, Japan, and Sweden.

IN Indianapolis, under a 300 ft. ceiling, I this. At this hotel, my last stop, I awakened by shrill female voices chanting "the girls from the District, are we, We'll for Vic-to-ry,—No man can deny us, no wa defy us,—We'll win for the district,—will Drummers sought fire-escapes, a Cleveland lurgist hid in a broom closet, I barricaded door. Then all was calm. Inquiry revealed the D.A.R. was having a convention and the was alleged to emanate from the District Columbia Delegation.

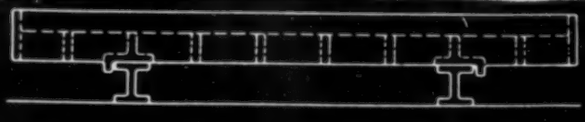
MIGUEL SIEGEL

THESE are topsy-turvy times—Can we k on pampering our culls till the cupboard bare? Literally, *the rats are watching the holes. A penny for your thoughts* upon read in press headlines "TIDAL WAVE SWE WASHINGTON." The sign in the lower pict page one, reads "Ring twice for ice water, th for hot water." If you're an A.S.M. Member attended Purdue, write for my skyview of P due, sent with our compliments. Intoler comes so easily. Renewed Virtue shines bright Having stopped smoking nearly two years a I find myself getting positively prissy ab smoking butts left under my nose, wander ashes, low visibility indoors.

LAST week I put Warren Noble, (my for partner in Noble & Harris, Consult-En neers), on S. S. Hamburg for Europe, travelli in *choice* company, and bound, among o things, for a survey of European Furnaces a Alloys, and markets for American Alloys a Furnaces. We've had many foreign inquiries license under G. A. Processes and H. H. Patents.

CHECK THESE SAVINGS

1



If this rigid tray for two rails weighs 100 lbs.—*then*—

2

This single hinge tray for same job will weigh appro

CAP'N GUS of H. H. H's. Yacht Guardian Puts Ships in Bottles.

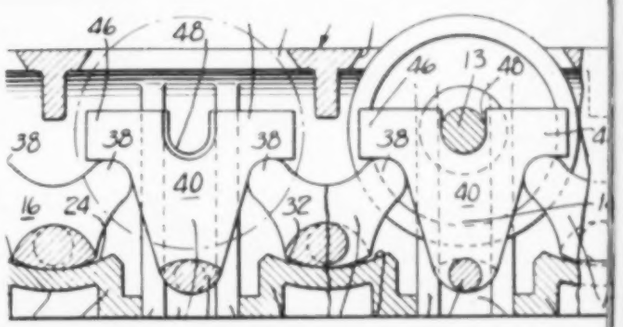
U realize, of course, that the compression load on a furnace tray is many, many times er than the load on the tray, that in all er furnaces you are paying for a costly "Ram-rod," which is *wholly unnecessary ght of technical advance* in furnace mechn as exhibited by G. A. at the National ls Exposition. These new mechanisms, plus ed-Trays, shown below, will cut your alloy 30 to 60%, effect greater operating econo- Anyone who tells you different is ignorant e art. G. A. Mechanisms will be released sted through established Furnace Builders

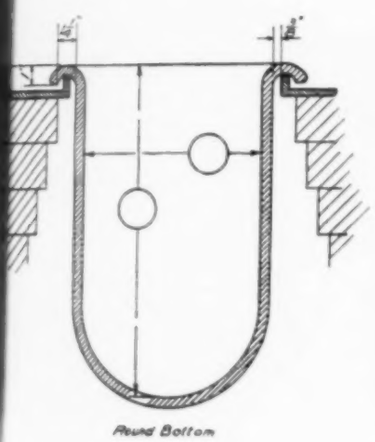
AT LAST! All the Rollers on a Roller Rail Work

OBVIOUS facts: 1. No furnace hearth remains level under heat. 2. No rough cast, crudely "ground" roller rail ever had rollers of uniform height. 3. No tray, or container going through any furnace, has a "flat" bottom. Only a part of the rollers in any roller rail bear on all trays, and that some bear on none. There are roller rails in service with **half the rollers not bearing.**

OBVIOUSLY, a roller rail with **all rollers bearing, equalizing** minor irregularities in hearth and trays, **avoiding flexing of trays,** is a great improvement. Such a rail can support muffles and retorts uniformly, permitting free expansion.

THE "SELF-LEVELING RAIL" SHOWN HEREWITH, AND MANY VARIATIONS, COVERING THE BASIC PRINCIPLES INVOLVED are covered by H.H.H. Patents applied for. The mechanism is simple as a rocking chair and is fully enclosed in a strong inverted "U" section "Muffle Rail." **Ask your furnace builder for these improved rails,** on your next furnace.



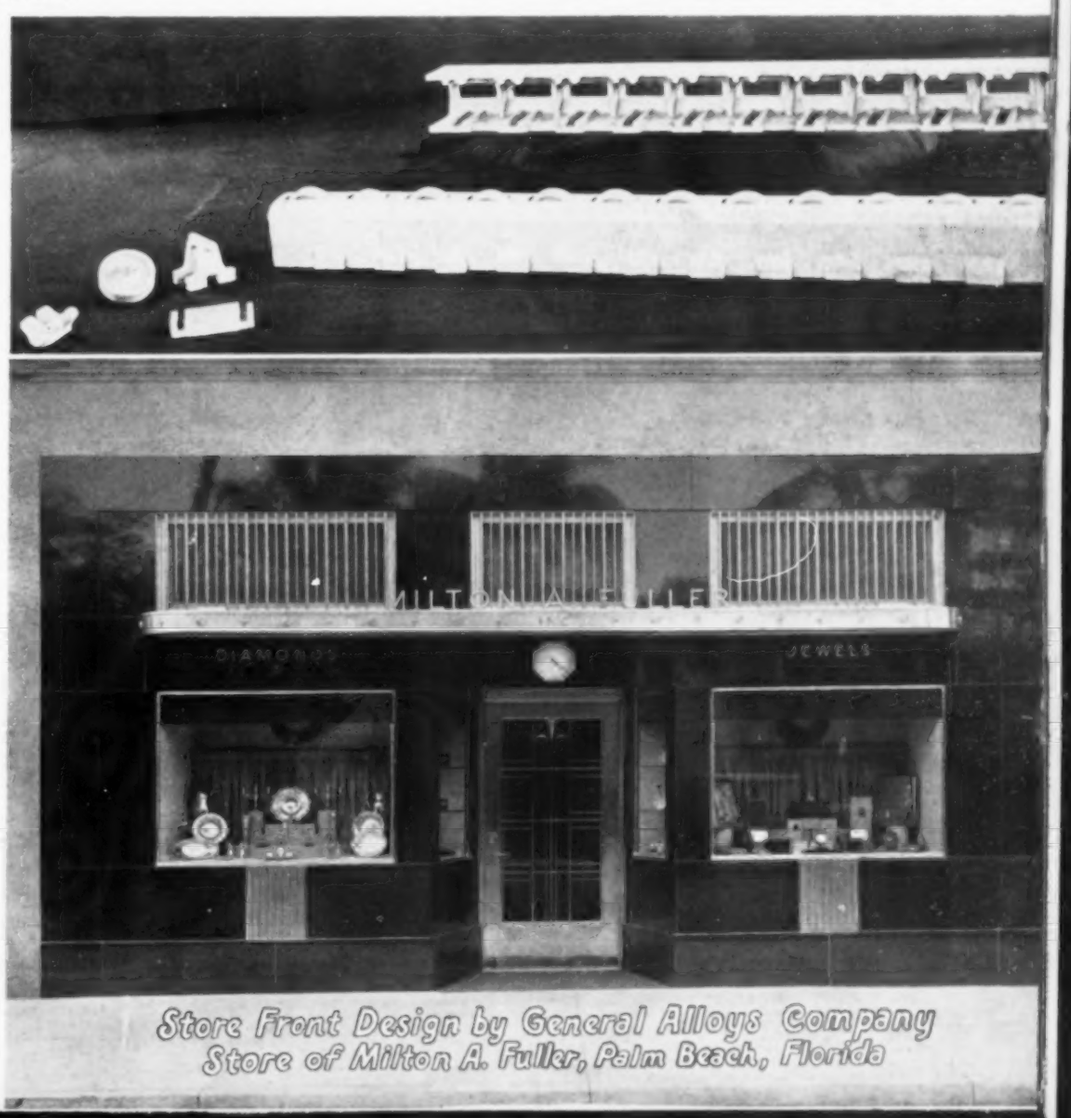


Round Bottom

N an Engineering project in Turkey, Warren Noble had unusual experiences, took down eral crucifixions. "The Turks," he states, ucify for sheep stealing and similar offenses. eir religion is against the taking of life, but do not regard crucifixion as 'Killing', for the ifixee *dies from exposure.* No one objects an 'unbeliever' de-crossing a crucifixee. If n down before the second exposure to midsun, their wounds heal quickly, they're soon good as new." What would those Turks to a Furnace Salesman,—who sold them rnace full of "Cheap" alloy rails,—when the s went haywire? In countries where you give r Grandmother a male soprano for Christmas, *fice is pointed.*

LBES claim the world depression started when the Sultan gave the Eunuchs another in 1930. (It has now been returned to them). d Pots, Cyanide Pots, all kinds of salt pots e better and last longer when made of lloy. We have many testimonials showing nomies up to 600%. The "Roll Flange" pot sign shown, *originated by G.A. 15 years ago,* ts longer, weighs less, transmits less heat loss, ps salts out of furnace. One "Flange Ring" lasts many pots.

(Continued on next page)



Store Front Design by General Alloys Company
Store of Milton A. Fuller, Palm Beach, Florida

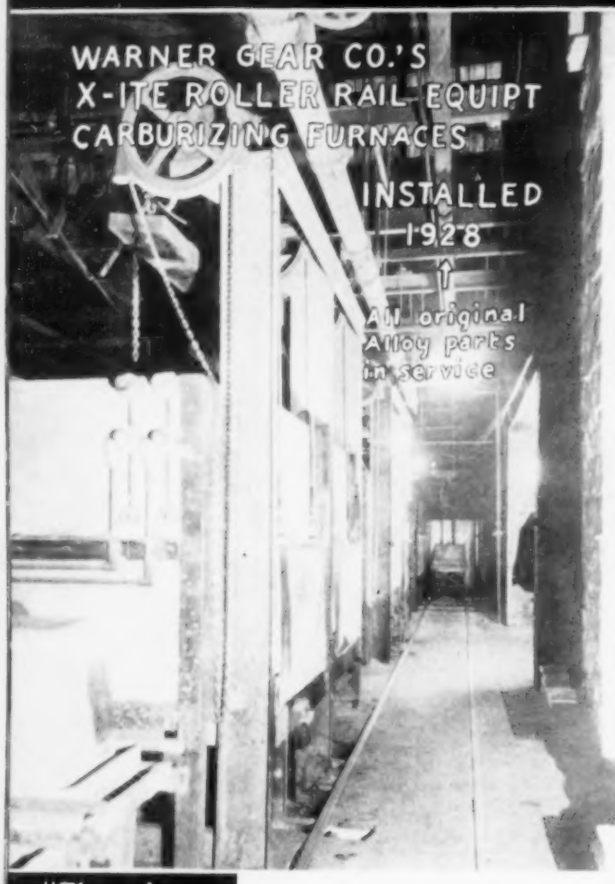
twin hinge 4-rail tray will weigh approximately 60 lbs.

A three hinge 5 rail tray will weigh approximately 48 lbs.

THE SAVING IS OBVIOUS

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

GA X-ITE GA O'ALLOYS GA X-ITE GA O'ALLOYS



FEW Metallurgists are as well known for their contributions to the technology, and to the economics of modern steel treating, as E. F. (Ernie) Davis, dynamic and popular Chief Metallurgist of Warner Gear Company, Muncie, (Division of the Borg-Warner Corporation). Because of this, and the prominence of his company, we are most gratified by Mr. Davis' kind words as follows:

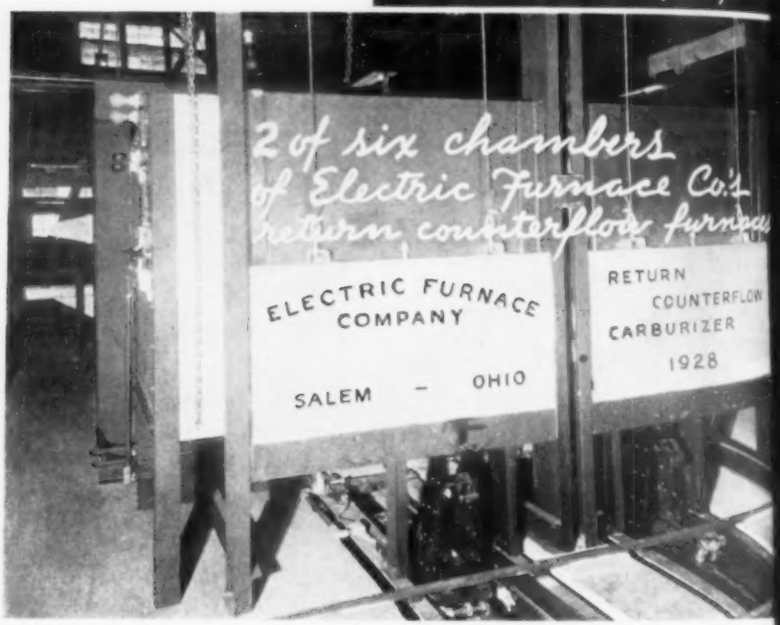
"THE original X-ite rails, rollers, and other vital working alloy parts of our furnaces, made by General Alloys Company, and installed in 1928, are all intact and in good condition. Because of this experience we have specified General Alloys' Alloys on all our new furnaces, and will not undertake the risks of experimentation with lesser known alloys sponsored by some furnace companies for reasons of initial economy."

THERE are hundreds of other veteran furnaces, five to nineteen years old, equipt with General Alloys Castings, *which handle the loads and do the work.* On the performance of these veterans are based the reputations of major furnace companies.

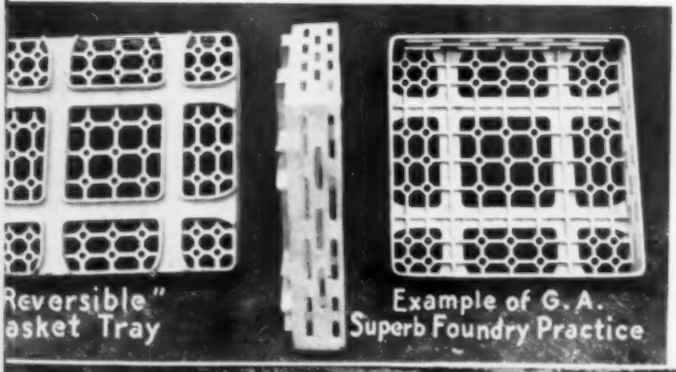
E. F. Davis—Chief Metallu
Warner Gear Company, Mun

"There is NO SUBSTITUTE for EXPERIENCE" and no alloy experience to compare with G. A.

WHEN buying any furnace, specify G.A. Castings and be sure of the BEST, backed by a REPUTABLE ESTABLISHED MAKER, a RESPONSIBLE DISTRICT REPRESENTATIVE, UNEQUALLED EXPERIENCE. When a furnace salesman first talks to you, ask him point blank whose alloy he is supplying, and judge his product by the reputation of his alloy maker. The alloy parts DO THE WORK UNDER HEAT, and "NO FURNACE IS BETTER THAN ITS ALLOY PARTS." If he's evasive about alloy, he'll probably supply you with the product of some "Chiseler", bought to save a few cents per pound. You have "chiselers" in your business, who need a "price advantage" to sell their stuff, nuf ced. The *cheapest insurance* for UNINTERRUPTED PRODUCTION in your furnaces is GOOD alloy parts.



CAP'N GUS, hard-boiled Skipper of the Yacht Guardian, our year-round residence, can sure take things out of bottles. But he's even better at putting things into bottles, —full rigged ships, for instance, and tidy schooners,—all made with loving care and assembled inside a bottle with technique to make an obstetrician look like a coal passer. Gus has wide renown as "The impressario of a Million Clams." If you ever want the low-down on an honest-to-Neptune clam bake, Cap'n Gus is at your service.



FOR six years, General Alloys has had the only Design Department in the stainless steel industry, is equipt to design anything from an Urn to a Sky-scraper in Stainless Steel. The Palm Beach store front is one of many G.A. designed jobs. To fully appreciate G.A. superb foundry practice in *Engineered Alloys* try to imagine some steel foundry turning out this job.

IF you have criticism of A.P.—Please be sport enough to write me. We want to please more readers—offend none.

OUR Scotch friend, "Doc" Braid, was overheard at Atlantic City talking earnestly and benevolently to a pert package, "Weel, tis oonly tae true thaa wooman pays, but ceen thus case I'll gie ye credit, wi' th' unn stoonding noo preceedunt weel be est lished."

WE have had many letters from lady commenting on *Alloy Progress.* One most outstanding ones was received fr charming wife of an Ohio A.S.M. meml follows:

Dear Mr. Harris, Happy New Year baited breath (guess what I used for b await the next issue of *Alloy Progress* just a young slip of a girl and can't a appreciate the deeper meaning of your zine, but I try awfully hard and I think Auto-Pan bed is just too cute. There som some subtle connection between the bea which you are giving us girls and that bo what can it be?

I have always wanted to meet you, si you are an old friend via Q-Alloy, bu husband never takes me to conventions so jealous! I don't know how he'll fee my accepting a bean slicer from another but hell, he's never given me one and h has to get ahead somehow, so I'll take th if you will. Thank you in advance, Mr. S Cordia

GENERAL ALLOYS COMPANY

367-405 W. FIRST ST., BOSTON, MASSACHUSETTS, U. S. A.

PLANTS
BOSTON, MASS.
CHAMPAIGN, ILL.

OFFICES AND REPRESENTATIVES

NEW YORK, 227 Fulton St.
CHICAGO, 80 E. Jackson Blvd.
PHILADELPHIA, W. T. Fitzpatrick, 400 Morris Bldg.
DETROIT, 4-137 Gen. Motors Bldg.
INDIANAPOLIS, Geo. O. Desautels Co., Postal Sta. Bldg.
ST. LOUIS, Randolph Wohltman, 315 No. Seventh St.
PITTSBURGH, W. F. Bender, 112 Thompson Drive, North Hills, Pittsburgh
MUNCIE, Geo. O. Desautels Co., 114 E. Washington St.
WEST HARTFORD, CONN., 716 Farmington Ave.
OHIO, H. G. Chase, Dist. Mgr., 199 W. Main St., Alliance
MILWAUKEE, C. R. Slensby, 1412 Bankers Bldg.
CLEVELAND, Hal W. Reynolds, 3346 Superior Ave.
HOUSTON, Gulf Engineering Co., Inc., 423 Broadway
BUFFALO, 812 Tacoma Ave.
TOLEDO, G. H. Stine, 616 N. Huron St.
RICHMOND, VA., J. F. Leonard, 3414 Noble Avenue
DAYTON, A. H. Valentine, 1926 So. Malvern Ave.
SAN FRANCISCO, S. Craig Alexander, 976 Clayton St.
FREMONT, M. K. Brattain, Memorial Park
LOS ANGELES, Allan Arm... N. Ridgewood

OLDEST AND LARGEST EXCLUSIVE MANUFACTURER OF HEAT & CORROSION RESISTANT ALLO

HOUSE ORGAN OF GENERAL ALLOYS COMPANY

ALLOY PROGRESS

Bright Spot in Metal Progress

EDITED BY [illegible] PRESIDENT

T ENTIRELY ABOUT HEAT AND CORROSION RESISTANT ALLOY CASTINGS

Why be a Guinea Pig?

HERE are sound reasons for being a "Guinea Pig" in the interests of ntific *Progress.* Progressive indi- als and corporations "Stick their s out" every day to try *improved* ign, *new materials,* in the hope for roved *reliability,* reduced operat- costs, improved product. Risk is cal wherever the prospective gain reat *enough to warrant* the RISK.

HE "saving," in *first* cost, of a few cents per pound in buying alloys m second and third string manufac- rs is generally less than a third fair "Premium" for *insuring* the K. Nothing *new* in metallurgy or ineering is offered. The first "Sav- " is the *last.*

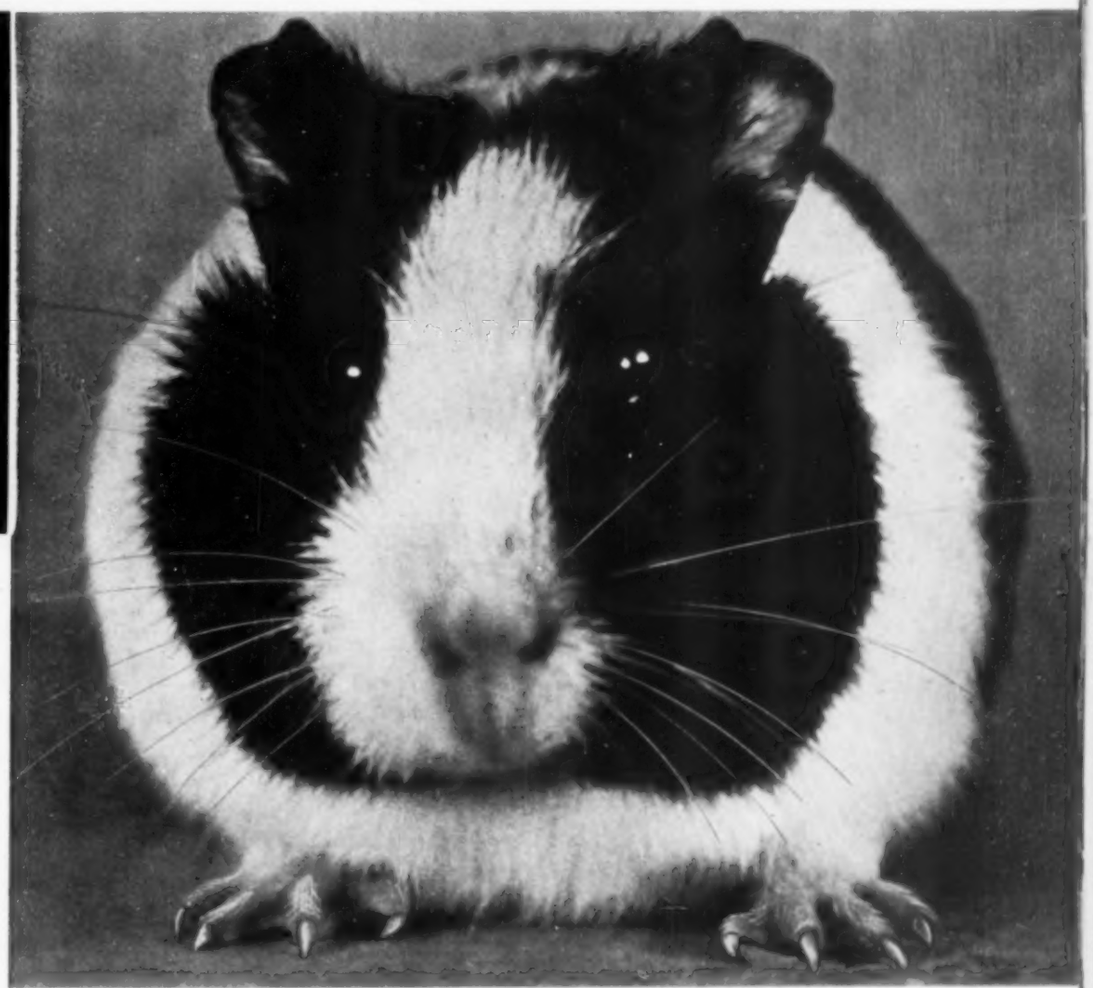
HE difference in cost between 100% specification of General Alloys e and "Left Wing" alloy for the l working parts of a $26,500.00 nace was $421.65. The difference service life expectancy is *several* rs. One broken roller could wreck usands of dollars worth of alloy s. *One* day's shut-down could en- production losses of $4,000.00.

E a "Guinea Pig" for Science and Progress, if you will, but don't let e alloy peddler, or his sales agent, penny-wise Furnace Salesman, inate you.

MAIDEN AT WELL

NCE-upon-a-time *(this story should be told to a nice girl curled up in your lap re a log fire, primed with a flagon of ted Port)* a young Prince was lost in a t desert. He wandered in great circles, gued and deceived by countless mirages merciless sun beat upon him by day sand fleas devoured him by nite. Thirst

(Continued on page 4)



NO FURNACE IS BETTER THAN ITS ALLOY PARTS

"CASANOVA," our whiskered rodent, was sired by "Brigham Young," who, we regret to relate, is slipping. The distinguishing white stripe facial marking of his offspring is going hyper-eutectoid. He still gets 'em between the eyes, but no longer "Right on the Nose."

"SI" Edwards, formerly Metallurgist with General Motors at Muncie, Ind., and well know to all old Steel Treaters, "Came to California FOR GOOD in 1924, is now Metallurgist of Industrial Steel Treating Company—technically "Tops"—of Oakland. He is high-spot Pacific Contact for all visiting A.S.M.'ers—also starring in Los Angeles Metal Show. "Si" was doing better gas and oil carburizing fifteen years ago than some of the experts are doing now. He's a crack photographer, sent me rolls of magnificent 35 m.m. nature-in-the Cal-raw-raw stuff, spoiled for A.P. cover enlargements by drug store film development. Use Champlain's developer (California Product), "Si", and forget grain.

"NEP," dog shown in last A.P., belongs to Frederick H. Parkin of the William M. Parkin Company, Pittsburgh. "NEP" is the trade mark of his company's highly effective inhibitor (see their answer to "Who Owns Nep" . . . their advertisement appearing on page opposite first page of Alloy Progress).

IF you've ever lost a canine pal, you'll appreciate our response to H. M. Nichols' "Please, who's got Rosk", I'd rather have this issue find Rosk than a dozen alloy orders.

IN January A.P. I wrote of Swedenborg, "Father of Modern Metallurgy." The 250th anniversary of his birth was January 29th. Swedish friends asked "Why no picture?" Myron Weiss, Associate Editor of Time, supplied this picture. (If you'd like an 8x10 photo, with our compliments, write for it on your letterhead).

BENJAMIN DeCASSERES writes of Swedenborg: "One of the most remarkable human beings who ever lived. Swedenborg was a chemist, mineralogist, geologist, scientist, botanist, clairvoyant and the founder of a religious sect known as Swedenborgians. He described the and the streets of heaven minutely. Like Leonardo Da Vinci and Swedenborg's brain seemed to be a house of all knowledge, human and vine." "A colossal soul," Emerson Swedenborg.

THERE are a lot of good Swedes ing on for Swedenborg. Steel Treating and Lindberg in Chicago carry the Swedenborg assisted by Fred Hansen, Danish ing Maestro. My Contax snapped Messrs. Brown, Stevenson and Hayden Lindberg Eng. when they dropped Boston Office last week. With those boys grabbing off page four, the Norse have bagged this issue. K. A. Jutheli four million rifles for the Allies, is nationally recognized as an ordnance pert, but he's the only Grandfather know who can do a forward or lacka flip somersault without touching his and land with his toes on a crack—hat and glasses in position. "K. A." recommended Q-Alloys for fifteen

SAW a big installation of 35 ni-Il carburizing boxes that looked, a few trips through the furnaces, like poor, tired lettuce—the "round trip" lettuce—that rides on salad plates in restaurants 'til it wears out. The nickel alloys last far longer per cost because they absorb less carbon, tain ductility to resist the terrific stresses of heating and cooling. Now direct quench supplanting box cooling outstanding advantages of Q-Alloy are doubly apparent.

WARREN NOBLE writes from Rut about his crossing on S. S. burg. "Half way across, a most ing thing happened. The Gyro machine went wrong and the ship into a complete circle at full speed took on a list of 31°, spilling coutrements, water out of washbowls ple in deck chairs into the scuppers it was necessary to stop her, first cover from the list, second to trouble.

"I thought she was never going back—I timed the list recovery minutes—which is a Hell of a long came, of course, from the anti- tanks, which were never made for such condition as that which arose— went under water and filled up—the of course, drained and it was conseq necessary to emergency pump the

"A broken spring-eye on the sion reactance relay caused When will people learn that spring turned up from the spring wire are *safe*, no matter how light the load. are only two safe ways, one, to turn spring, as a nut, onto a threaded the other to reduce the coil size sively about a bead on a hook shank a rough day the 'Hamburg' could been lost with all hands with no of communication."

Norwegian Elk Hound, was lost or stolen in ...k Hills. Owner H. M. Nichols, Manager of ...antic Refining Company, Philadelphia. Reward.

George McCormick G. A. V. P. gets the inside story of a Surface Combustion Gas Carburizer.

—Spend your vacation in New England • Write us for booklet

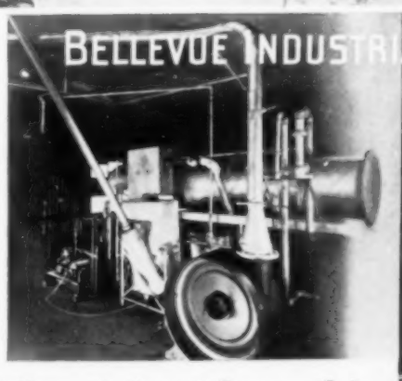
...you are an A.S.M. Member and attended ...M.I.T., write, on your letterhead, for an ...print of my skyview with our compli...ents.

...LAYER of a dying negro in Peoria Police ...Station: "Lawd, here I comes, tune me a ...mptious harp, Lawd—and Lawd, oh Lawdy, ...me one o' dem teazin', tantalizin' tan ...ls tuh whang it fuh me."

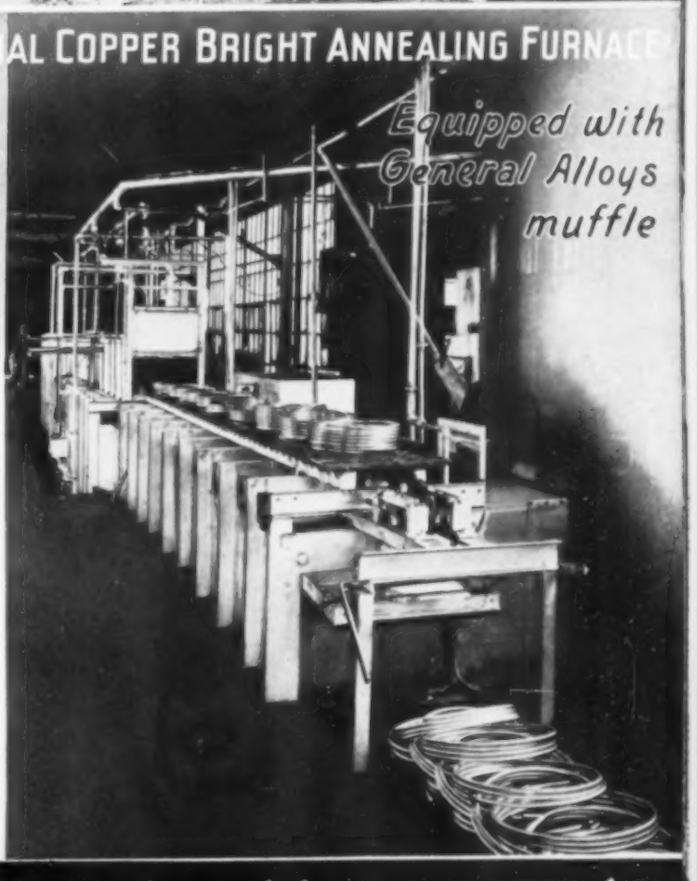
...RS. Edward N. Johnson's mink scarf was ...stolen from the St. Moritz Hotel, N. Y. In ...rt court, Mr. Johnson identified the scarf. ...at one was Willie," he told the startled ...rd. "We raised him, my wife designed him ...that scarf." Mink farmer in Ontario, John... was once a District Attorney in Wisconsin, ...butes his election to "The unconscious con... of the voters". *Unconscious voters may ...k U. S.*

...OW TO "HEDGE" INFLATION

...ERE is no such thing as "Inflation" until ...its presence becomes known. Its pres... does not become known until the ac...ability of money decreases. A Milwaukee ...ain of Engineers helped chase the "Frit... into Germany, and, resting in Rhein, ...ked a superb little Fraeulein, who saved ...pay and salary from his generous Mil...ee company. Reluctantly returning from ...exotic warmth, news of German inflation ...ed him greatly until a cable came, "Lieb... all our money safe. Nodding maddens. ...chen." Returning later he found her Faith... Ardent, and Affluent, rich beyond hopes, ...ying beyond dreams. Coming out of the ...he asked: "Precious one, how did you ...inflation?" "Dot vos easy, Liebchen," ...purred, "I bought mit American dollars ...coffins by each dollar, drei Vare-hausen ...hop-haus by the Brewery, gefilled. People ...always needing coffins. Now I sell them ...forty dollars each." Back in Milwaukee, ...ought his wife a Cadillac coupe, built an ...e, is still a "big shot." He's looking for... to another war.



BELLEVUE INDUSTRIAL COPPER BRIGHT ANNEALING FURNACE



Bellevue Industrial Furnace Co's. New Atmosphere Furnace

INSTALLED at the Roberts Tube Works, Detroit, this remarkable Copper Bright Annealing Furnace has proven such economies over many preceding types that great interest has been created among copper and brass Metallurgists and Engineers.

A SPECIAL "Cracking Unit" produces an atmosphere containing 4½% CO, 7½% CO_2, balance Nitrogen, without a trace of free oxygen, at suprisingly low cost, burning gas with six times its volume of air, and removing sulphur from the product.

THERE are four sections: A non-heated dead-end, which is an "Air-Lock";—An "Elevator Compartment";—Muffle Heating Zone;—Cooling Chamber, fan cooled to 150° F. The trays are moved WITHOUT COMPRESSION by an ingenious chain conveyor.

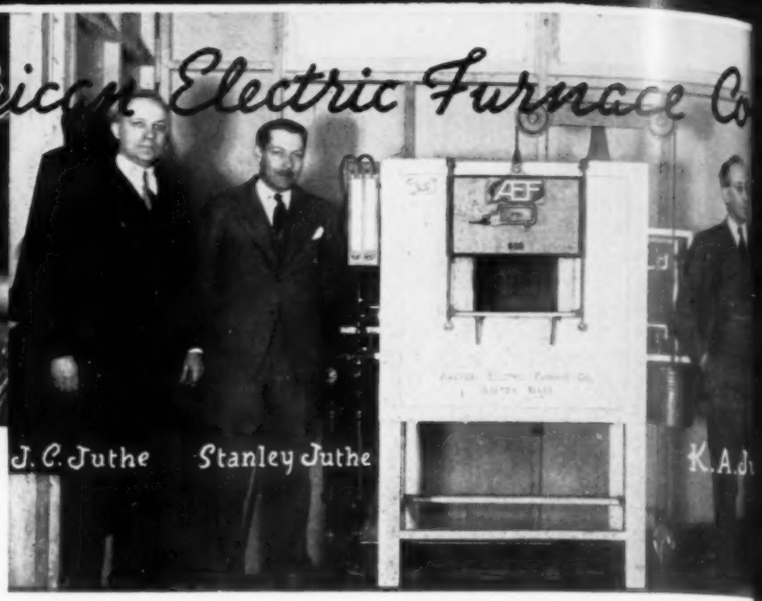
X-ite Muffle and all Alloy Parts by General Alloys

THE total length of the furnace is 96' 6," compactly arranged in double-decked "U" shape. X-ite Muffle is 23 ft. long by 33" wide x 15" high. THE CAPACITY OF THIS FURNACE IS ONE TON PER HOUR ON 1200 Cu.Ft. of 1000 B.T.U. GAS.

manufacturer should know best the value of his own produci
t is why a few foundries ask less for their stuff.

Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite

No "Recession" at American Electric Furnace Co



K. A. JUTHE, President of the American Electric Furnace Company, announces receipt of the largest contracts in the Company's history, totaling over $300,000 in value of electric furnaces. Contracts include roller rail carburizing and annealing furnaces, continuous clean hardening retort furnaces, batch type furnaces, etc., all having controlled atmospheres.

THE continuous clean hardening retorts, among the largest yet built, are of unique design and construction, offering many advantages, not the least of which are that, in the design of muffles and retorts proper consideration has been given to alloy properties and foundry practice to insure maximum life.

ALL the alloy parts, conveyor mechanisms, retorts, muffles, hearths, etc., will be made in X-ite or other Q-Alloy grades and represent the cooperative efforts of the American Electric Furnace Company's engineering staff and General Alloys' engineers.

THE American Electric Furnaces with "AMERICAN" Atmospheric Control are adapted for practically any heat treating operation up to 2500° F., including perfected heat treatment of high speed steel.

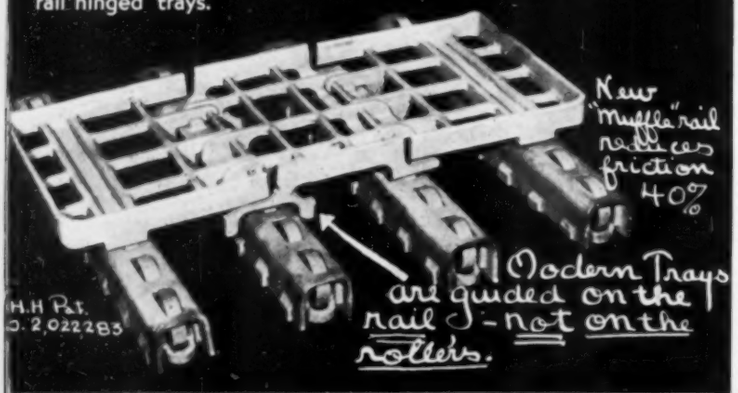
"AMERICAN" Atmosphere Control provides 100% control of the "gas curtain" across the door, and of the atmosphere surrounding the work. This atmosphere can be varied to suit requirements, positively protecting the work from decarburization and oxidation—with negligible grain growth and distortion in high speed steels.

WITH a rich New England background of p... cision heat treating and more than 20 ye... experience in building furnaces for the third ... users, the Juthes and their associates offer out... ing furnaces.

"AMERICAN" furnaces—of size and ... intermediate between box furnaces and la... conveyor furnaces—offer mechanical loading ... and discharge of charge—automatic or semi-automa... as desired.

WRITE THEM for bulletins 25 and 45 to Ame... can Electric Furnace Company, 27 Van Bu... Street, Boston.

Modernize your old pusher furnace to save 40 percent in tray weight and get 30 percent increased life with multiple rail hinged trays.



WE REPEAT

THE advantages of the HINGED TRAY are too obvious to be ignored. Not only do Hinged Trays save in first cost through lighter weight, but they last much longer, save fuel and handling cost, often increase production. They can carry heavier overloads. The cost of one or more extra rails is generally saved on the reduced tray cost on one set of trays. As five or more sets of trays are used to one set of rails, THE ECONOMIES ARE OBVIOUS.

FURNACE Salesmen who sell their customers wide span two-rail furnaces, with wide tray overhangs, merely to save an extra rail, **less than 5% of the furnace cost**, are penalizing the customer **50% to 100% higher tray maintenance cost** than would be insured by HINGED TRAYS. The tray savings on Hinged Trays could, in some cases, pay for the furnace.

ANY TRAY SPAN OVER 12" WITH LOADS OVER 25 lbs. per sq. ft. IS A COSTLY WASTE OF ALLOY TRAYS. IT'S RIDICULOUS TO "SAVE" A FEW HUNDRED DOLLARS ON A FURNACE AND GET STUCK FOR SEVERAL THOUSAND IN TRAY MAINTENANCE. Call in a G. A. man before you buy any furnace, and get your alloy up to date.

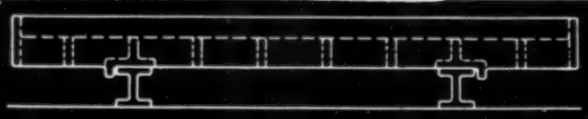
MAIDEN AT WELL

(Continued from page 1)

consumed him as a flame. Thrice circli... vultures spiralled in swift descent to ho... as waning life in spurts of hope drove hi... forward. Suddenly cool moisture-lad... air found his distended nostrils—a ma... charge of hope engulfed him—strea... throbbed in his limbs—the breath of ... Oasis drew him rejoicing to a beauti... garden, rising from the desert like Q-Allo... above the herd. He came upon a surpa... ingly beautiful maiden, lithe of limb a... firm in budding grace, gazing into a w... of clear, cool water, who smiled swee... upon him. "Oh please, beautiful Maiden... plead our Prince, "May I partake of yo... cool, clear water, for my soul and my bo... share the thirst of life?" "Oh yes, ki... Sir," quoth the beautiful maiden, "... may drink of my cool, clear water—b... only on condition that you will promi... to drink all the water from my well, a... never, never, drink a drop of water fr... any other well as long as thou shalt live." Our Prince, being a gentleman, and unab... in truth to so promise, died of thirst.

CHECK THESE SAVINGS

1



If this rigid tray for two rails weighs 100 lbs.—*then*—

2

This single hinge tray for same job will weigh approx.

A twin hinge 4-rail tray will weigh approximately 60 lbs.

4

A three hinge 5-rail tray will weigh approximately 48 lbs.

THE SAVING IS OBVIOUS

GENERAL ALLOYS COMPANY

367-405 W. FIRST ST., BOSTON, MASSACHUSETTS, U. S. A.

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OHIO, H. G. Chase, Dist. Mgr., 199 W. Main St., Alliance
CLEVELAND, Hal W. Reynolds, 3346 Superior Ave.
TOLEDO, G. H. Stine, 616 N. Huron St.
DAYTON, A. H. Valentine, 1928 So. Mahers...
CHICAGO, 80 E. Jackson Blvd.
MUNCIE, Geo. O. Desautels Co., 114 E. Washington St.
PHILADELPHIA, W. T. Fitzpatrick, 400 Morris Bldg.
INDIANAPOLIS, Geo. O. Desautels Co., Postal Sta. Bldg.
WEST HARTFORD, CONN., 716 Farmington Ave.
MILWAUKEE, C. R. Slensby, 1412 Bankers Bldg.
HOUSTON, Gulf Engineering Co., Inc., 423 Broadway
RICHMOND, VA., J. F. Leonard, 3414 Noble Avenue
SAN FRANCISCO, S. Craig Alexander, 976 Clayton St.
LOS ANGELES, J. Allan Arnold..., 103 ... Ridgewood ...

OLDEST AND LARGEST EXCLUSIVE MANUFACTURER OF HEAT & CORROSION RESISTANT ALLO...

HOUSE ORGAN OF Q-ALLOYS To Be Alert GENERAL ALLOYS COMPANY

EDITED BY R. E. Harris PRESIDENT

ALLOY PROGRESS

Bright Spot in Metal Progress

ENTIRELY ABOUT HEAT & CORROSION RESISTANT ALLOY CASTINGS

"Pass the Soap"

"WHO Shall Ascend Into The Hill Of The Lord?
Or Who Shall Stand In His Holy Place?
. . . He That Hath Clean Hands And A Pure Heart."
Twenty-fourth Psalm.

"WHO Art Thou, Politicus, That From Thy Own Cesspool Thou Shalt Impugne The Aroma Of Thy Neighbor"—Tiberious.

"NONE Among Men Shall Wax To Such Extreme Righteousness As The Undetected Transgressor"—Peter Stuyvesant.

IS the average American really so naive as to seriously credit politics with a monopoly or even a modicum of virtue?—or is there a remote possibility that the reform pendulum will swing from the accused to the accusors?

AMERICAN Business, literally the political brother's keeper, might risk a gesture in keeping with the reform spirit and contribute a slogan—"LET'S PASS THE SOAP TO POLITICS."

R. E. Harris

Cut courtesy of International Nickel Co.

NO FURNACE IS BETTER THAN ITS ALLOY PARTS

Here Comes John Heckman
(General Alloys District Manager in Chicago)

OUT COMES A GAMERA

SO many people have asked how I combine the simple chores of flying an airplane and taking pictures alone, that I shot these pictures of G.A.'s John Heckman, flying his newest plane and operating one of my skyview cameras. Nothing to it, just stall the plane, hands-off, side-slip at the subject, and co-ordinate your gun-eye, rudder-foot, and trigger finger, changing film and setting shutter sub-consciously.

A FRIEND of mine with three older sisters said he was of age before he found that pieces of candy don't come in a box with small bites out of them.

IN Genoa, birthplace of Columbus, over incomparable vermouth and under superb mosaics, my Italian friend, Signor Scavia spoke to me of Italy's labours at the birth of Fascism. The Genoa City Council, radical laborites and Communists, drunk with power and privilege voted city funds to relieve Communists in Russia. Italian Patriots, led by tradesmen and workers, threw them out. They had gone too far.

LOOKING at Cazenova, A. P. Guinea Pig, and studying Felix, the kitchen-tiger, I am impressed by their patrician side whiskers. Whiskers so long that they are more than a "Snozzle Gauge," for they tell their owners, in the dark, that there is full clearance for their bodies before they proceed. What we humans need is some kind of whiskers to warn us not to "stick our necks out" too far.

NO single item in alloy design has been such a pain in the neck alloy manufacturers, furnace builde and,—of course,—the users, as tr for gas carburizing furnaces,—partic larly when they are quenched. At l we have perfected a tray with no int sections, no differential metal sectio no ribs,—designed to be quenched are quenching this tray every fif minutes from 1750 into water. If y want to smarten up on alloy try do this with any tray you ever saw.

RECENT good reading: Arnold Kamiot's "Critique of Poor Re son," proving "the fallacies of popu thought" and Cedric Belfrage's "Aw from It All."

FOR two years steady, our breakfa has been a double orange juice w half a lemon and an egg beaten I drink it standing up, omit the wa of time and ritual called "Breakfas absorb needed protein and vitami Try it a few days, and you'll start streamlined day feeling much better.

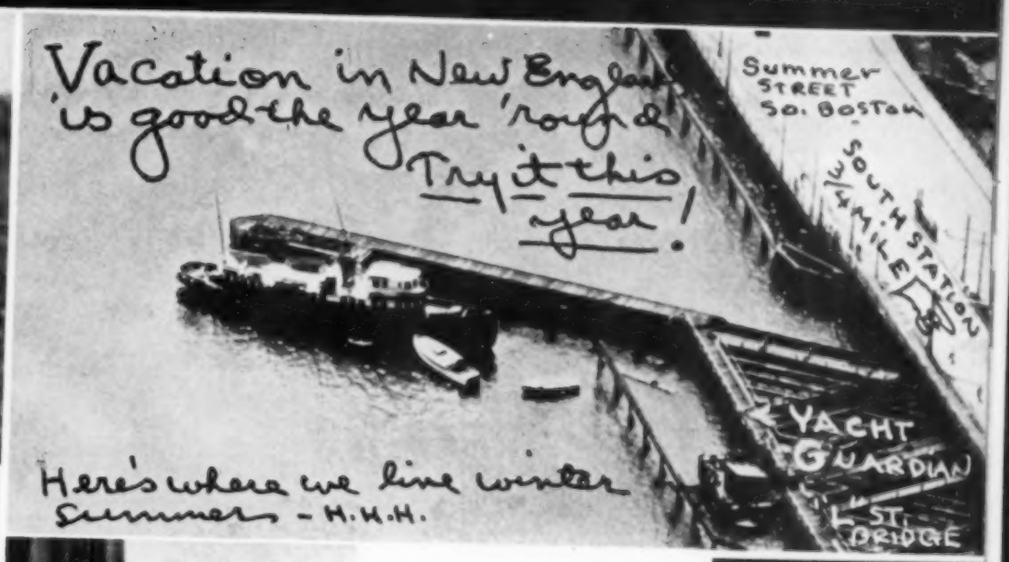
GEORGES LE ROQUE, famed anim trainer, was offered 100 ounces gold dust by a California prospect if he could teach his burro "Nelle" cook. "That was asking too muc says Le Roque, "but I did teach a Bernard to spit once, just to keep h from drooling. He can now lie on t hearth-rug and drown flies on the ce ing."

IF you are considering any conver hearth furnace of any kind, ask re furnace builder about G. A. "SPIR LINK," the only self-aligning h hearth ever built. Six leading Furna Builders have adopted them. Write for photos.

STUMBLING across my war-pla album I found this picture Quentin Roosevelt's body and pla shot down behind the German l

THE FOOTPRINTS OF GENERAL ALLOYS
GA VITE QALLOYS GA QALLOYS GA VI

Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite


Vacation in New England is good the year 'round & Try it this year!
Summer STREET So. BOSTON
SOUTH STATION 1¼ MILES
YACHT GUARDIAN
1 ST. BRIDGE
Here's where we live winter Summers - H.H.H.

ther, of his first crude grave, marked with his dy's tribute, I had sent to Kermit Roosevelt. e we were suckers when we walked into that iting station, what do you think?

you are an A.S.M. Member and attended Ohio tate University, write for an 8 x 10 enlargement aerial photograph with our compliments.

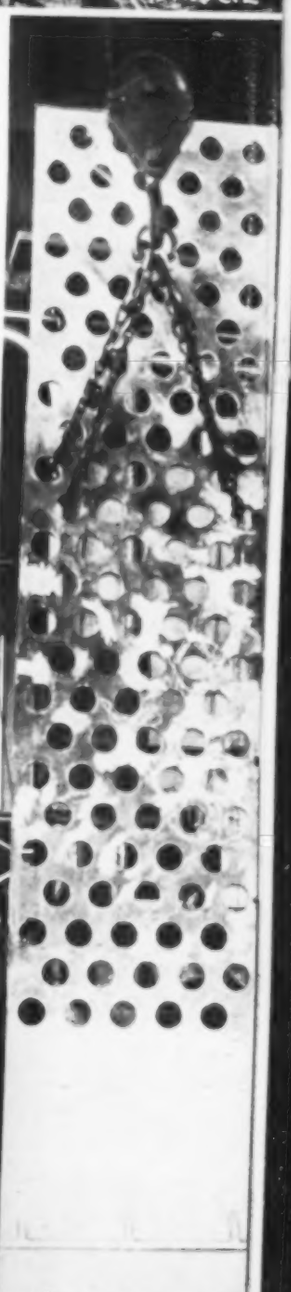
NEAKING up on an eagle about to pounce on his prey is just a bit of a problem for a photographer. aking up on the ultimate economy in your heat t is much easier, you just specify Q-Alloys.

AJOR, our Great Dane, has since puppyhood been passing across a drawbridge near which we dock "Guardian." For the first time, yesterday, he was he bridge when it started to open, felt the ground r him rolling away, saw a huge hole open up ith him. He whined and trembled, ignorant of trange machinations that made part of his world ut from under him. Men felt that way in mber, 1929. Are we on a "drawbridge" *now*?

A RESIDENT of Illinois, dirt farmer from Champaign County, I've always been boat-crazy—keep the Guardian in commission summer and winter. Water does not change temperature rapidly, is normally much warmer than the air in winter, cooler in summer. Fred Ryan's automatic oil heat, and two inches of cork insulation, plus the Atlantic Ocean, two Scotties, a Great Dane, and a speed boat to the airport would make life bearable if we didn't read newspapers.

BECAUSE of General Alloys fine foundry practice in Carburizing Boxes, Furnace Trays, Stainless Steel Castings,—such stuff as our clock that kept time at 2000° F.,—some people forget we make the large, relatively simple castings like this big Oil Still Tube Support, with far greater accuracy and closer metallurgical control.

MAJOR is editing our "Dog Number." If you haven't sent in a snap-shot of *your* Purp, do-it-now. "Flash" Gillette will be society editor. He dogs for "Doc" Gillette, the big-shot at Battelle Memorial Institute. Flash has the coldest nose in Columbus. Frankly, we've been holding off the Dog Number, to see if business has really gone to the dogs.

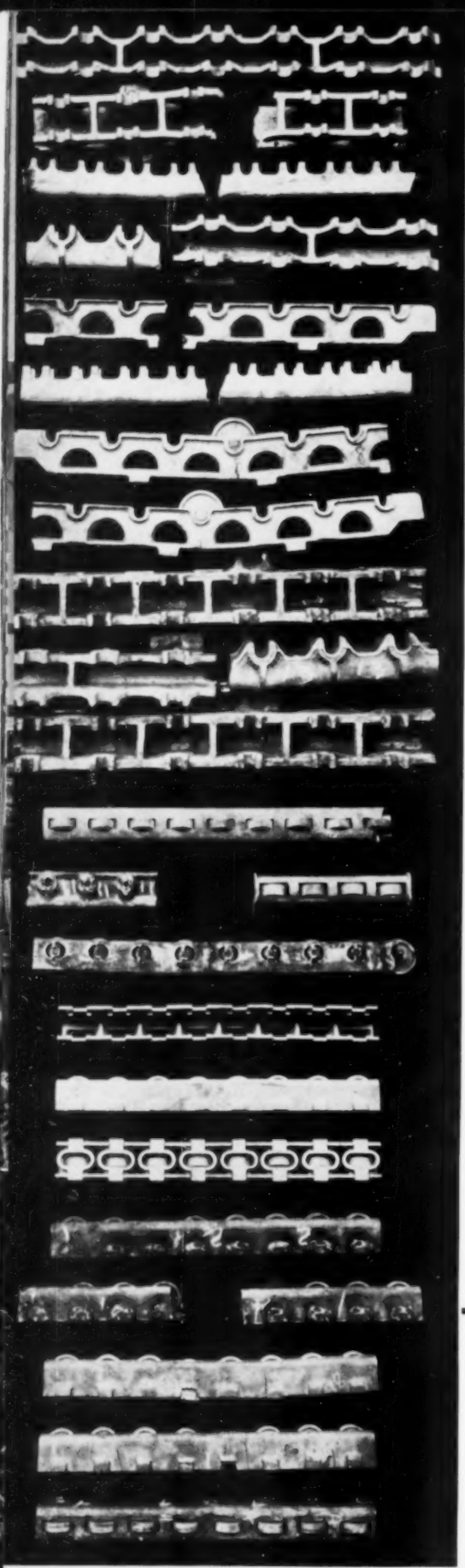


THE pile of X-ite roller rails, after ten years of service in a carburizing furnace at Warner Gear Company, Muncie, Ind., are being re-installed by the Electric Furnace Company, builders of the original furnace, in the rebuilt furnace, now being erected at Warner Automotive Parts Corporation, another Borg-Warner Subsidiary, at Auburn, Indiana. These rails will last longer on the second installation than a new set of "Cheap" alloy rails.

I RECENTLY rescinded a resolution of ten years' standing not to write "technical" papers, or address meetings, when I slipped and made a "Coffee Talk" to the Boston Chapter A.S.M. Next came Worcester Chapter, and now a paper at the American Foundrymen's Association Convention. I have a new formula: Take four dozen slides, shuffle them, let the Chairman cut the deck, deal and spiel.

I'D like to get A. P. Readers' ideas on our offering a prize for amateur photographers, or running a photographic number. Cadillac, Link-Belt, and scores of companies have Camera Clubs, hundreds of our readers take photos. Winners could be exhibited at A.S.M. Shows. What do you think?

BECOME THE PATH OF AN INDUSTRY
GA X-ITE GA Q-ALLOYS GA X-ITE GA Q-ALLOYS



THE high standards of Leeds & Northrup engineering and manufacture give them a unique and enviable position too well known to require elaboration. The famous "HUMP" and "HOMO" Furnaces of L. & N. manufacture, coupled with the precision of L. & N. Pyrometer Controls, are found in plants where quality of product is a first consideration, yet their operating economies excell cheaper substitutes, proving the old maxim, "The Best Is Cheaper in the End."

IN the Furnace Division of the L. & N. Plant, (Assembly Section shown above), modern facilities, fine craftsmanship, and high-quality materials combine to create CUSTOMER SATISFACTION.

THE cut-away section shows internal design and construction of a modern L. & N. "HOMO" Furnace. The fan, air deflector castings, basket support castings, and insulator support castings on heater are all General Alloys Products. LEEDS & NORTHRUP DOES NOT COMPROMISE WITH QUALITY.

"SWEET Mither, may all the Saints presairve us" smote our ears in a shrill Irish brogue from the bedroom of our suite at the Biltmore. Mrs. H. had left small charcoal dog-biscuits on the dresser tray, where, for a week the maid had been filching and eating them,—until,—when she read the label on a new box,—the prayerful ejaculation above quoted issued forth.

TRAVELING in Shanghai, Larry Welch was intrigued by a Chinese store sign reading "Ay Won Inc.," flying an American flag big as a harem sheet. He went in, met the owner, Sam Silverstein of St. Louis. "Vell, I'm from Missouri,—these Japs have gotta show me," says Sam.

TESTING THE LOAD CARRYING ABILITIES, AND FRICTIONAL FACTORS OF ROLLER RAILS, is the only intelligent approach to the design of better rails for better furnaces. The rails shown at left have been sandblasted for inspection after overload tests at temperature by G. A. Metallurgists. There is a variation of more than 50% in strength-to-weight ratios, and of 105% in friction under a given load. (Rail friction determines how much alloy you use "as a ramrod" in your trays). G. A. has the only test data on comparative rail design in existence. Our vastly improved new rail designs have been developed from these tests, in cooperation with leading Furnace Builders. SPECIFY G. A.

"There is NO SUBSTITUT for EXPERIENC and no allo experience t compare with G

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TOLEDO, G. H. Stine, 616 N. Huron St.
DAYTON, A. H. V... 1126 So. Main
CHICAGO, 80 E. Jackson Blvd.
MUNCIE, Geo. O. Desautels Co., 114 E. Washington St.
PHILADELPHIA, W. T. Fitzpatrick, 400 Morris Bldg.
INDIANAPOLIS, Geo. O. Desautels Co., Postal Sta. Bldg.
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LOS ANGE... Allen Alexa... 10... N. Ridgew...

OLDEST AND LARGEST EXCLUSIVE MANUFACTURER OF HEAT & CORROSION RESISTANT ALLO

HOUSE ORGAN OF ALLOYS To Be Alloyed GENERAL ALLOYS COMPANY

ALLOY PROGRESS

EDITED BY [illegible] PRESIDENT

Bright Spot in Metal Progress

ENTIRELY ABOUT HEAT & CORROSION RESISTANT ALLOY CASTINGS

UN and JERRY, Great Danes, now deceased, looking ... over at Monterey Beach. (You will remember them ... and ... A.S.M. shows.)

A Tribute to the Dog

One of the most beautiful tributes ever paid a dumb animal came from the lips of the late Senator George Graham Vest. The occasion was a trial over the killing of a dog which was held in a Missouri town when he was a young lawyer. Young Vest appeared for the plaintiff and made the following address:

"GENTLEMEN of the Jury—the best friend a man has in the world may turn against him and become his enemy. His son or daughter that he has reared with loving care may prove ungrateful. Those who are nearest and dearest to us, those whom we trust with our happiness and our good name, may become traitors to their faith. The money that a man has, he may lose.

It flies away from him, perhaps when he needs it most. A man's reputation may be sacrificed in a moment of ill-considered action. The people who are prone to fall on their knees to do us honor when success is with us, may be the first to throw the stone of malice when failure settles its cloud upon our heads.

The one absolutely unselfish friend that man can have in this selfish world, the one that never deserts him, the one that never proves ungrateful or treacherous is his dog. A man's dog stands by him in prosperity and in poverty, in health and in sickness. He will sleep on the cold ground, where the wintry winds blow and the snow drives fiercely, if only he may be near his master's side. He will kiss the hand that has no food to offer; he will lick the wounds and sores that come in encounter with the roughness of the world. He guards the sleep of his pauper master as if he were a prince. When all other friends desert, he remains. When riches take wings, and reputation falls to pieces, he is as constant in his love as the sun in its journey through the heavens.

If fortune drives the master forth an outcast in the world, friendless and homeless, the faithful dog asks no higher privilege than that of accompanying him, to guard him against danger, to fight against his enemies. And when the last scene of all comes, and death takes his master in its embrace and his body is laid away in the cold ground, no matter if all other friends pursue their way, there by the graveside will the noble dog be found, his head between his paws, his eyes sad, but open in alert watchfulness, faithful and true even in death."

When he concluded his remarks there were but few dry eyes in the audience. The case was submitted without further argument, and the jury promptly returned a verdict for the plaintiff.

No furnace is better than its Alloy Parts

"THERE is a lot of G.M.'s and P.A.'s I pitch horseshoes with today who were 'in conference' last fall," says Bismark. "I am cutting my hay rain or shine, and where there is no hay, I plant a few seeds towards next year's crop . . . Sure, I'm happy, and when I can't get an order, I bring out my dice."

"I'll Sit on My Tail and Wait"—Says Purp

"PURPO'S" mama, "Gretchen," warned him wisely as a pup, "It's a hell of a life. If you stand still, they jump you and if you run, they bite you in the tail." So Purpo's solution is—"I'll just sit on my tail and wait," which under present conditions, is a decision worthy of a congressman.

WE DON'T insinuate that business has gone to the dogs. It is a question, how far can a dog or a business go into the woods? We reply without conviction, "Only half way in, for after that, the way is out."

THE Great Dane is known as "the silent watch dog"; he just lifts a leg and the intruder, fearful of being kicked, decamps.

J. FENIMORE COOPER, JR., Metallurgical Engineering student at University of Illinois, sends the swell picture of Snooty. Victor L. Holm at Harrison Steel, Attica, Ind., writes: "My pal, Duffer, will chase anything that walks or flies, including butterflies, and is as alive as he looks." A. Gordon King of American Gas Association sends the fine picture of the Caesarian twins, Rock Rimmon Sandra, Rock Rimmon Sandman, who with R. R. Peggy, their mother, and Peter, on stool, are our "Reception Committee."

"CRESS" KITE of E. F. Houghton NYC, says, "Chick" points blonds and sets on red heads.

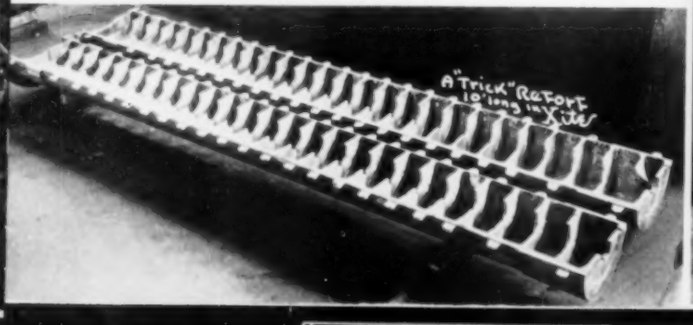
WE GOT so many dog pictures left out Major, Dan and Roger Dane and sea-going Scotties, and about 30 pictures left over which we use later. If you have a dog, send a picture.

PICTURE Bob Weaver, Ferro-Enamel President, as "Balzac" in a pink bonnet, where I saw him tonight on Hanna stage, Cleveland, in the Hecht play, "Hold your Hats," packed with pink pulchritude and *enjoying* it. A fine characterization.

NINE cases of Streptococci infection in quick succession were carried of St. Frances' Hospital, Evanston, first; number ten, John Heckman, eight blood transfusions in six days back at his desk in our Chicago office hoping that he has some Spanish blood in his veins, watching for symptoms.

"The Time Is Here"—Brown

"BLUEBEARD," Bill Heath (above) and "Rocky," J. M. Zaverine (left), both waiting for their masters in the "Great Beyond" if said "G. Beyond" is worth waiting for.



NOT an aerial photograph in this number, with in the sweat box. Stopped off at MacFadd P.C. joint in Dansville, N. Y., to chop a little wood sweat a few bullets on the anxious seat.

IF YOU haven't a steam cabinet, pick any chair front of any stock ticker.

DELIVERED a paper at the American Foundr men's convention entitled "The Role of Heat sisting Alloys in Short Cycle Malleableizing Furnace If you can stand such stuff, write for a copy.

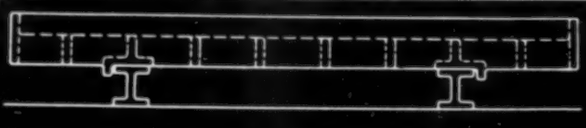
THIS week we are off to the races at Indianapo and the annual Borg-Warner race dinner as guest of Pres. Davis, of Borg-Warner. We may some pictures.

BEATING a breakdown, my Fairchild plane got new spring set of tailwires. I've stopped wait for them to break. How about your lead and cyan pots, why not anticipate failure, and prolong life w new Q-Alloy pots?

IT'S like parting with an old friend, to discard single sheet of carbon paper over which pounded out every one of the last eighteen issues Alloy Progress. The spirit of sincere craftsmanship lives in any product.

CHECK THESE SAVINGS

1



If this rigid tray for two rails weighs 100 lbs.—*then*—

2

This single hinge tray for same job will weigh appr

"There is No Substitute for Experience"

Alloy Casting Manufacturer Approximates GA Experience

AIRMAIL week, emphasizing Lingbergh's transatlantic mail trip brings bright memories of his landing in Paris. Wedding trippers, we stood on the field cafe roof at Le Bourget when Lindy landed. I had the first post-cards commemorating his flight printed, mailed them to U. S. where they are now collectors' items. Most fun was collecting bets from surprised French friends. Other memories are of air service Buddies who met death carrying mail sans instruments in Pennsylvania hills, and of army pilots killed by politics.

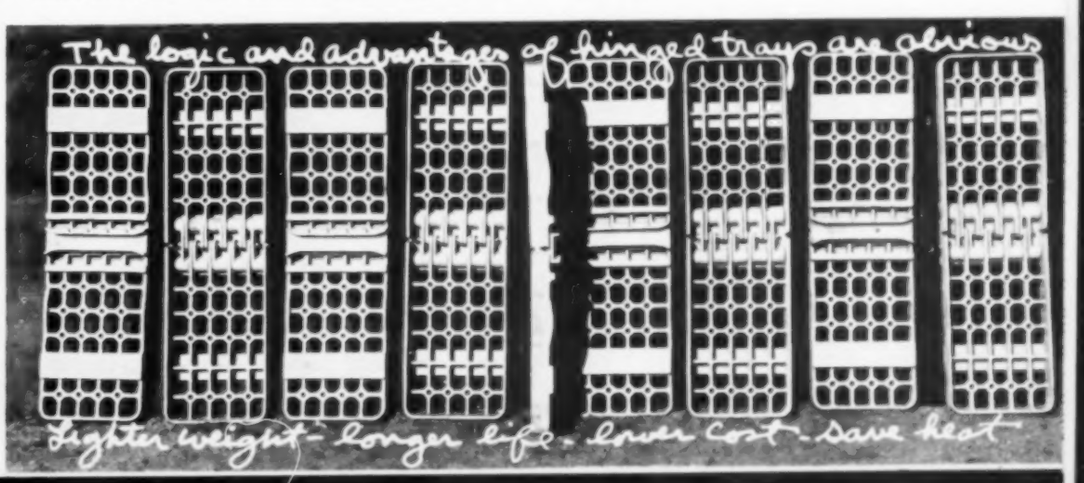
DUE to recent developments in furnace mechanism, pioneered by General Alloys in cooperation with leading furnace builders, there is little further justification for building more long pusher furnaces, in which alloy trays are used as a ramrod. Such furnaces have to be run at 100% capacity or filled full of "dummies." To empty them before a shut-down, it is necessary to run in a dummy charge on trays, which dummy charge must be brought to heat and ejected when the furnace is started up. The Smooth-Screw conveyor, the In-a-rail chain, or the Side-winder, all covered in the November issue of Alloy Progress, obsolete long pusher furnaces.

WARREN NOBLE writes: "Crammed with enthusiasm about Czechoslovakia, the place is amazing, there is more in beauty, design, craftsmanship to be seen in an hour's walk in the Prague shopping district than in a year elsewhere, but the Hotel Alcorn, that is kept by direct descendants of Ali Baba."

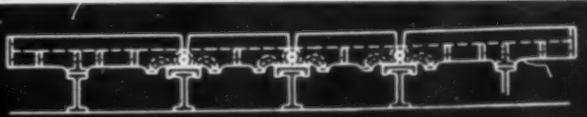
LIKE thankfully buried dead arising to haunt me comes a wire from Metal Progress that our "Birth of a Baby" copy is rejected, and in Pittsburgh after five solid hours of flying the Ohio.

GAS carburizing has been handicapped by low grade alloy specifications, bought on price from poor pattern equipment, and by designing highly involved special trays, sometimes four or five different designs for one installation, merely to make the fixtures supporting the work fit into the trays like a picture puzzle of toadstools growing through a grid. It is better to make simple standard trays, on which cumulative experience can be gained and design and manufacture perfected, and put self supporting fixtures upon them.

TO GET low costs on any carburizing job SPECIFY GENERAL ALLOYS. If you use trays in any pusher furnace, hinged trays (below) will save you money.



A twin hinge 4-rail tray will weigh approximately 60 lbs.



A three hinge 5-rail tray will weigh approximately 48 lbs.

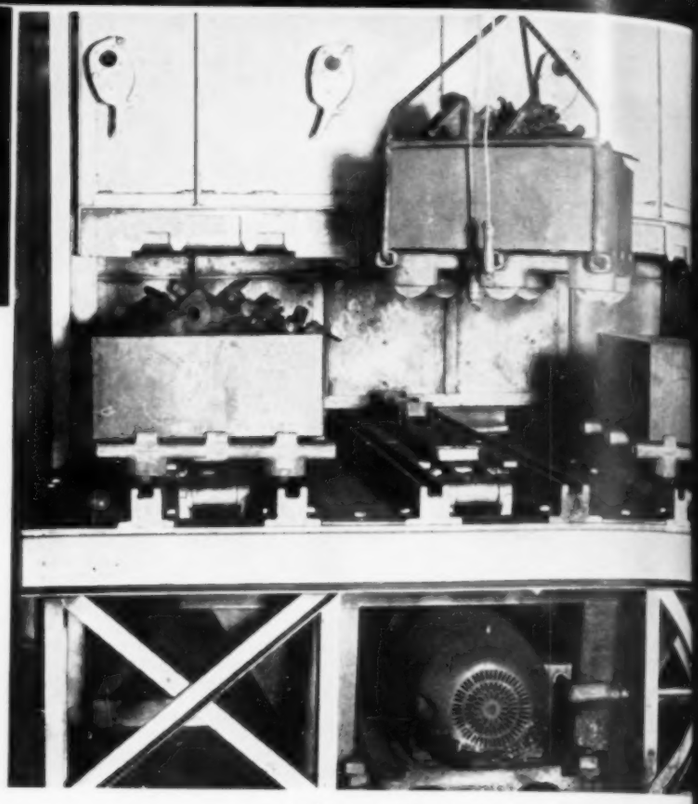
THE SAVING IS OBVIOUS

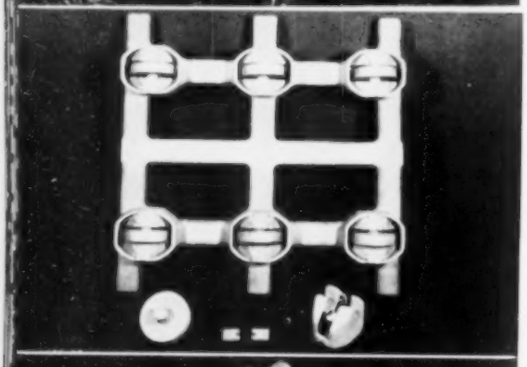
G-A ALLOYS

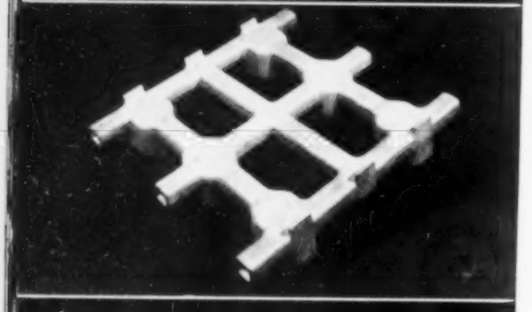
THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION

X-ite

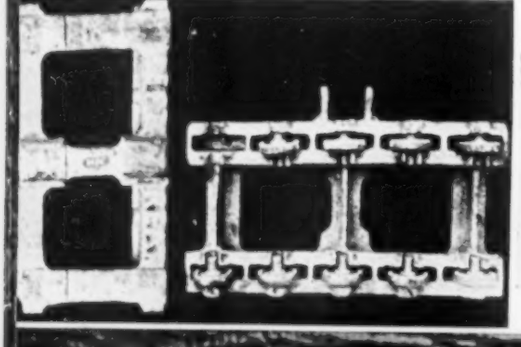
"There is NO SUBSTITUTE for EXPERIENCE"
and no alloy experience to compare with G.A.







Allegheny, Monongahela, Youghiogheny, and Kiskiminitas river valleys, "copy" comes hard. (I think I'll balance my slumber budget and cut A.P. down to two pages). Bob Chew, Manager of Ladd Equipment Company, our Pittsburgh Representatives, wanted airphotos of Pittsburgh plants, few of which have been photographed because they generally lie in canyon like valleys, which pocket smoke and create treacherous bumpy air currents. Today I shot twenty-nine twelve exposure film magazines, turned part of the grey finish on my plane yellow from sulphur smoke, learned Pittsburgh geography. Asked about Pittsburgh weather, the U. S. Weather Bureau man observed, "Well, when I moved to Pittsburgh, last year, I had to light my lights driving into town at two P.M.—Nordics tarnish here." The late beloved Will Rogers said "To find an airport, just follow a high tension line till it crosses another one." Just a minor hazard, —for soon a brand new steel mill, with stacks below the level of the new Pittsburgh Allegheny County airport, will be laying such a smoke screen for visiting pilots, that they'll have to put cheese-maggots on as co-pilots to guide them through it. *And Politics wants to run business.* Recently, leading airlines ran a "Special," "Bring your wife with you as our guest on your plane trip." Dumb publicity departments addressed letters to wives registered;—"Dear Mrs. Whatzis, we hope you enjoyed your trip, etc." Many wives were surprised.



Reproduced from Transactions A. S. S. T., April, 1926

"HOT BUGGIES"

THIS latest type of Continuous Short-Cycle Malleableizing Furnace recently built by Surface Combustion Corporation, and equipt 100% with General Alloys' Alloys uses less alloy than any job of similar capacity with simpler alloy maintenance. ALL MOVING ALLOY PARTS COME OUT OF THE FURNACE.

WITH more than fifteen years experience with alloy cars operated at high temperatures, G.A. is qualified to design, make and guarantee cars for any load equipt with our new "Twin-bloc" renewable bearing, and tubular chassis (Pats. Pending). Lower left illustration is an X-ite alloy transfer car after ten years continuous operation in an Electric Furnace Company Carburizing Furnace. We'll put rollers on trays, carburizing boxes, car-bottom furnaces, or what have you, and reduce your alloy mechanism to a minimum, with all moving parts accessible. THE ENGINEERING IN THE ALLOY BUSINESS IS 90% G.A. *Many old designs are too costly if you got them for nothing.*

THIS reminds us of Mrs. Cleveland Metallurgist who received a strange new silver-fox scarf "she overlooked in packing" from an Atlantic City hotel. She kept it.

"WHY do our warmest friends always have the coldest noses, Duffer?" asks Snooty.

I'M embarrassed to be in agreement with the Government. The Department of Commerce just bought twenty-three Fairchild planes, like mine, is going to take its own medicine.

CAPT. EBEN BRIGHAM, 83, sat on Fish Wharf in Gloucester stirring saltpetre into his snuff box. "Just to get these Spring notions out of this old grey head."

Geo. McCormick's Double-Barrelled Golf Hound, X-ite

GENERAL ALLOYS COMPANY

367-405 W. FIRST ST., BOSTON, MASSACHUSETTS, U. S. A.

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HOUSTON, Gulf Engineering Co., Inc., 423 Broadway
CLEVELAND, Hal W. Reynolds, 3346 Superior Ave.
RICHMOND, VA., J. F. Leonard, 3414 Noble Avenue
TOLEDO, G. H. Stine, 616 N. Huron St.
SAN FRANCISCO, S. Craig Alexander, 976 Clayton St.
DAYTON, A. H. Valentine, 1[illegible] So. Main St.
LOS ANGELES, Allen Arnold, 10[illegible] N. Ridgewood

OLDEST AND LARGEST EXCLUSIVE MANUFACTURER OF HEAT & CORROSION RESISTANT ALLOY

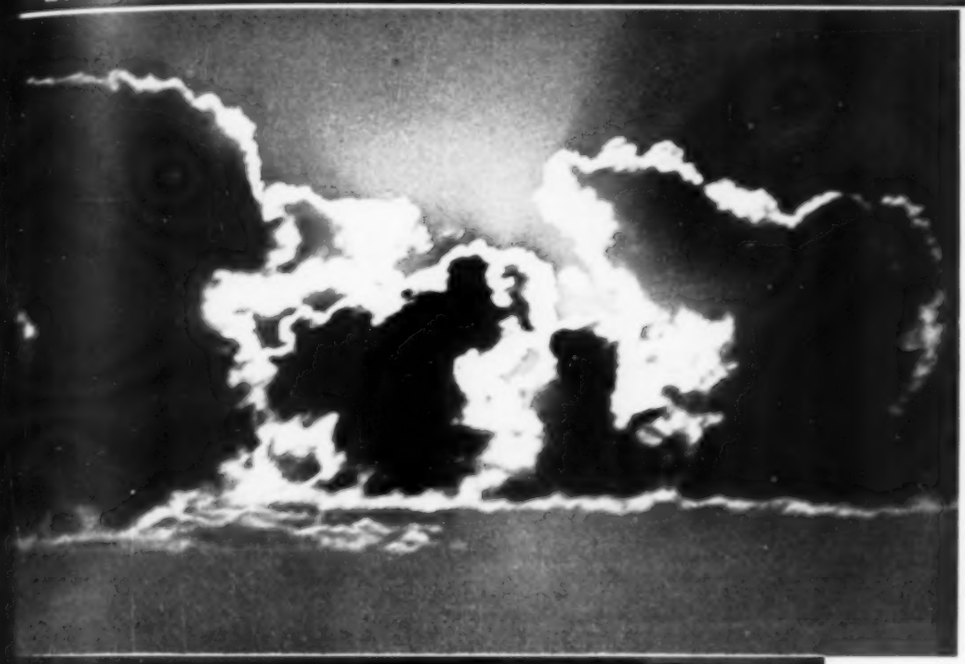
HOUSE ORGAN OF Q-ALLOYS "To Be-A Fact" GENERAL ALLOYS COMPANY

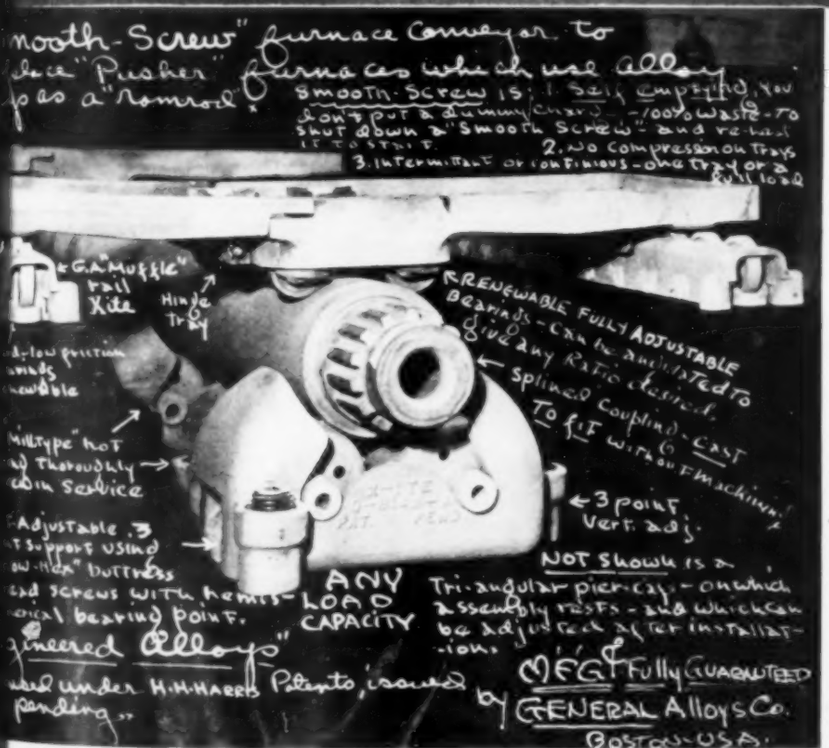
ALLOY PROGRESS

EDITED BY H. H. Harris PRESIDENT

Bright Spot in Metal Progress

ENTIRELY ABOUT HEAT & CORROSION RESISTANT ALLOY CASTING




"Smooth-Screw" furnace Conveyor to
place "Pusher" furnaces which use alloy
as a "nonrod"
SMOOTH-SCREW IS: 1. Self emptying, you
don't put a dummy charge in - 100% waste - to
shut down a "Smooth Screw" and re-heat
IT TO START
2. NO Compression on Trays
3. INTERMITTENT OR CONTINUOUS - one tray or a
full load
"GA" Muffle" rail Kite
Hinge tray
RENEWABLE FULLY ADJUSTABLE
Bearings - Can be annihilated to
give any Ratio desired
Splined Coupling - CAST
To fit without Machining
3 point Vert. adj.
NOT Shown is a
Tri-angular pier-adj. - on which
assembly rests - and which can
be adjusted after installation.
ANY LOAD CAPACITY
MFG Fully GUARANTEED
by GENERAL ALLOYS Co.
BOSTON-USA.
Patents issued
pending"

THE Smooth Screw furnace conveyor above shown is self-discharging. (You don't have to push a dummy load in to *stop, re-heat it and push it out again to start* on every shut-down.)

As the thrust on trays in pusher furnaces is generally ten to twenty-five times the load carried on the tray, the great increase in alloy life and reduction of alloy weight by eliminating this thrust and its accompanying stresses is obvious.

SMOOTH Screw can operate from one to one hundred per cent of capacity, whereas pusher furnaces must be run completely loaded.

IMAGINATION

REMEMBER when you used to lie on your back, on a grassy hillside staring at the sky, while your eyes and your mind's eye pieced together fascinating pictures from the elusive configurations of passing clouds?

WEAVING collossal silhouettes from the vapours of the sky has been a pastime of dreamers, thinkers and ageless children since time began, when men first looked heavenward for hope—in the glories of sunrise, solace under the stars, or cowed before the thunderbolts of angered Gods.

A SENSE of participation in the scheme of things, an inner satisfaction, comes with the return of one's imagination from any successful quest. Whether picking out pictures in the clouds I fly through, or picking the seed of a new patent out of the air, I get a real kick watching my imaginings take shape and,—don't we all?

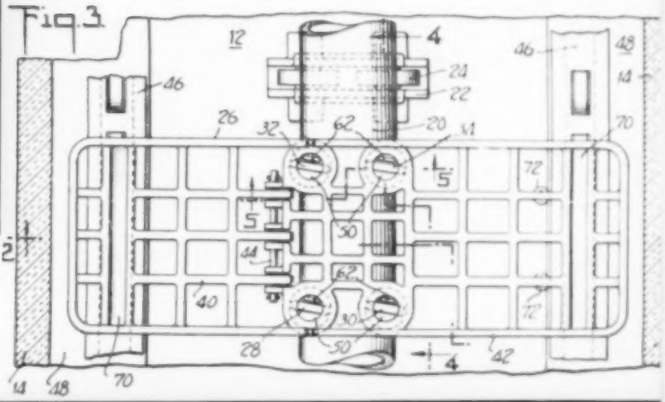
TWO years ago I flew into, and photographed the magnificent sunset which became the title-head of ALLOY PROGRESS. Twenty times we have re-issued it, blind to the clear-cut picture of "The Lady and the Lion" in the very center of that sunset. Recently, a lady reader called it to my attention.

IT'S hardest of all, perhaps, to use our imagination in our own business, or shine a light in our own rut, yet no man can deny that our only certainty is change, and our only progress forward. "He who dares to anticipate change launches his ship upon the high tide."

I STRIVE to harness my own shackled imagination to the task of functionally analyzing alloy applications and alloy furnace mechanism,—convinced that there is great room for improvement—and then *doing something about it.* Whenever we offer improvements,—on the time-honored "Pusher tray" furnace mechanism for example,—there is a chorus of "Well, it's worked satisfactorily for years." *SO DID THE OX CART.*

H. H. H.

Fig. 3



Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

GA X-ITE GA Q-ALLOYS GA X-ITE GA Q-ALLOYS

THE Holcroft gas carburizer above shown in the No. 2 plant of Warner Gear Company at Muncie, Indiana, marks a step forward in this type of furnace, for the trays and fixtures have been coordinated with the objects, not only of minimizing net to gross ratio, but also to give proper consideration to alloy design and alloy life.

TWO types of X-ite trays are used, both of which function merely as carriers for fixtures. On top of these rest the fixtures which are so inter-related that they remain upright without being keyed to the trays. Work treated, may be changed without altering the tray design.

MANY gas carburizing trays have been built into all manner of compromise forms because their designers conceived the idea of supporting the fixtures like umbrellas fitted into sockets in the tray, each combination of center distances requiring a different tray,—several different designs of trays being frequently required on one job. The new G. A. trays are standard for a given size furnace—can benefit from cumulative experience.

MESSRS. Talley and Dauch make a good team of hard hitters and straight putters, whether on their job of operating George J. Hagan Company, outstanding furnace builders of Pittsburgh, or shooting golf.

AN outstanding achievement of their combined talents are the new Hagan box carburizing furnaces, two recent installations of which are in the largest concerns in their respective lines in America, and are operating with X-ite roller rails and Q-Alloy carburizing trays and boxes.

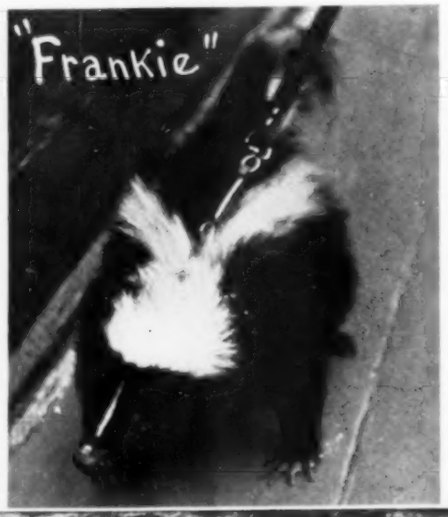
"WE believe that these new Hagan 'recuperative-type' furnaces equipped with Q-Alloys boxes are turning out the highest quality and lowest cost carburizing to be found anywhere. Box carburizing in Hagan furnaces has many advantages," says Al. Dauch.

GEORGE J. HAGAN COMPANY will welcome any inquiries for furnaces equipped with G. A. mechanisms, knowing from 16 years experience, G. A. castings give satisfaction and uninterrupted service in Hagan furnaces.

AS we go to press August Sixteenth comes word of the death of C. M. "Slats" Slensby, Milwaukee Representative of G. A., of a burst appendix. "Slats," Old Man, we feel so futile, and inarticulate in the presence of Death,—helplessly standing by, even as I now helplessly fumble for words to frame surging thoughts. We've lost a strong and able friend, who stood out among men, giving us pride in our association with him. Eminently successful in his chosen calling, "Slats" would probably say "Just call me a SALESMAN," *to which hundreds will add* "and a *MAN* and a *FRIEND*."

I couldn't resist buying Frankie, winsome Sachet Kittie, (Skunk to you). He caught my nose and held my eye in downtown Boston where a peddler of Liliputian Bibles used him for "draw." Frankie had killed his pal Johnnie fighting over the latter's fiancee Violet, who, unimpressed, skedaddled. Since creation Skunks have had unchallenged right-of-way.

THREE hundred generations, it is estimated, will be required to breed into them a respect for the bright eyed animals with the round rubber feet, who run them down on the highways.



"Slats" Slensby and Major

FRANKIE is "De-Skunked"—"scentless," which, like "Pa... dentistry, is a relative term, and is ... barrassed shooting "blanks"!!

CAPT. Gus and I had quite a ... getting Frankie into his ... leather brassiere. He chewed ... wool lined flying gloves and swore ... thing awful.

AT "21" I bumped into an ex-... girl I knew years ago, still ... fancy, with all the bumps in the ... places, but grown a bit thicker ... ing an icebox. She married well ... the fur business, on the third ... husband impressed me as satisfied ... G. A. Customer. I marvel at how ... prize packages go through the mails ... so little breakage. Reminiscing, she ... how Ned Weyburn, selecting a ... chorus, had 1400 feminine finalists ... New Amsterdam theatre. Addressing ... he said, "Every Follies Girl must ... perfect example of American Womanhood ... beautiful in body and soul, ... every measurement. She must have ... torso of Venus, with hair, eyes and ... to delight a Raphael. Her character ... such that women and men alike shall ... well of her and she must radiate ... charm and personality, possess the ... of Diana. I now ask every young ... present who falls short of these ... specifications by so much as an ... to please leave this theatre." ... *woman moved*. Yes, the men have ... ego, too,—but, Ladies, we ask you, ... have *that much*?

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RICHMOND, Va., T. Spencer Williamson, Jr., Inc., Mutual Bldg.
CLEVELAND, Hal W. Reynolds, 3346 Superior Ave.
WASHINGTON, D. C., Shirley, Olcutt & Nichols, Mills Bldg.
TOLEDO, G. H. Stine, 616 N. Huron St.
DAYTON, A. H. Vo... 1926 So. Main...
BALTIMORE, Chas. F. ... 229 So. ...

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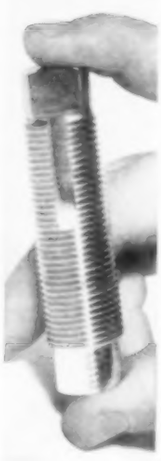
COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

JANUARY — "Bridgeport" BRASS — 1938

WEAR RESISTANCE FEATURES SILICON BRONZE PARTS

High resistance to wear is a feature of silicon bronze alloys which is leading to their increased use in the automotive industry and in many other applications requiring the combination of high mechanical strength with practicable ease of working.



Typical of the possibilities of the silicon bronze alloys is a gear thrust screw for rear axles. *Duronze III was selected for this part by a manufacturer who had formerly used aluminum bronze. Duronze III, extensively employed for gears, pinions, and high-strength screw machine parts, was found to be less expensive for the application than aluminum bronze. Gearing to steel, an intrinsic requirement of the service, caused no greater wear on the Duronze groove than it had on the previously used aluminum bronze part.

The gear thrust screw, formed from a standard ⅞-inch diameter Duronze III rod, is a single example of the possibilities of securing best results at minimum cost through a careful study of the requirements of the application.

Duronze III rod for screw machine products averages about 100,000 lbs. in tensile strength. Hot forgings made from this alloy average 90,000 lbs. per sq. in. in tensile strength. It is about 14% lighter in weight than copper.

Bronze Windows Tested

Bronze windows have been found to give exceptionally good results in preventing infiltration of air and dust, according to reports of tests recently conducted at New York University. One window tested permitted the passage of only 0.14 cubic foot of air per minute per foot of sash perimeter. Standard Government specifications allow infiltrations up to 1.25 cubic feet per minute.

The tests indicate interesting possibilities for bronze window manufacturers. Exclusion of dust and reduction in heating costs should prove arguments to increase the market for this type of material.

BRASS FABRICATION AND FINISHING COSTS CUT BY MORE CAREFUL SELECTION OF METAL

Original Selection of Materials Governs Cost Accounting At Every Step in Production of the Finished Product

It is the original purchase of materials of brass, bronze or copper which controls to a large degree both the twin items in direct factory expense—labor and materials costs—in the fabrication of products.

Labor charges—usually the major item in product costs—depend upon the time required for the various operations to which the stocks of sheet, rod, wire or tubing are subjected. And the ease with which they can be worked determines the time required.

This is especially true where these materials are subjected to a large number of forming and finishing operations, but are not annealed by the consumer for secondary operations. Sheet brass, bronze, and copper are cut, bent, punched, drawn, or drilled, in manufacture, and finally subjected to a finishing operation of buffing, plating, lacquering, enameling, etc. Labor charges, especially for finishing operations, may easily become abnormally high if proper care is not taken in the selection of materials.

The most suitable sheet, rod, wire or tube for any application can be selected only after careful consideration of the requirements of the *complete* job. Two basic factors are involved: the metal must have the characteristics required by the finished product, and it must permit carrying out the forming *and* finishing operations at the minimum factory cost.

In order to give best results, stocks of the alloys are commonly made to order, under definite specifications such as width, thickness, surface, hardness, etc. The user of metals is seldom in a position to convert his requirements into terms of complete specifications. The best solution is for the manufacturer to give a full explanation of his requirements to the brass mill.

Cooperation In Metal Selection

The engineering and metallurgical staffs of the Bridgeport Brass Company regularly cooperate with manufacturers in the selection of alloys to meet either normal or exceptional requirements. Because of their intensive metallurgical background they are able to suggest the alloy and other specifications which best suit the consumer's needs, from the standpoint of service requirements of the finished product and also of most economical production.

Equally important with the original selection of material is the assurance that on subsequent orders the characteristics of the original batch will be duplicated. Expert metallurgical supervision permits the Bridgeport Brass Company to supply materials of uniform characteristics on order after order, the electric furnace making possible higher and more uniform quality.

Personnel and equipment enable Bridgeport to supply the fabricator of brass, bronze and copper with the material which best suits all his requirements, and to duplicate specifications. This technical service is available free of charge to customers to help them solve their metal problems.

●"Workability" of brass sheet is vitally important in fabricating such items as those shown. Above is a filler cap for gasoline tanks and at right is a fire extinguisher part. Both are made from sheet brass and illustrate how proper characteristics of the metal are absolutely necessary for fabrication of products that undergo severe forming operations.

PREPARED EACH MONTH BY THE BRIDGEPORT BRASS COMPANY

Headquarters for Brass, Bronze and Copper

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A quick-drying coating is said to be suitable for protecting chromium-plated, lacquered, or enameled parts during shipping or storage. The coating is a black liquid, applied by spraying, brushing, or dipping. It dries quickly into a tough, black film, which can be readily removed when desired by washing with ordinary solvents, such as gasoline.

A gear shift features a new metal spray gun which can be used for spraying with copper, brass, and bronze when gun is in low gear. If necessary to use the gun with metals of lower melting points, the gun can be thrown into high gear.

A portable machine for sanding, rubbing, and polishing is said to be equally useful for smoothing metal surfaces, for removing old coats of finish, or for sanding between coats in a finishing process. Interchangeable blocks permit ready adaptation of the machine to any of these service requirements.

A metal-working machine combines attachments for lathe, milling, shaping, or drill work. Milling machine and shaper are built around the headstock; drill-press is at the front of the machine.

Pipe threaders for 2½, 3, 3½, and 4-inch pipe have fully enclosed gears to keep out chips and dirt. Markings indicate proper position for dies to cut standard thread.

A plating rack coating is said to be suitable for the insulation of racks used in plating with copper, nickel, and cadmium. It is reported to withstand temperatures up to 220°.

Speed lathes are said to be suitable for finishing, polishing, or lapping small parts. Lathes are fitted with automatic brake. They are recommended for the final operation on shafts and screw machine parts.

Disconnect switches rated at 4,000 amperes use terminals integral with switch contacts. All bolts, nuts, and washers in the live part of switch are of non-ferrous materials. Terminals of the clamp type accommodate 4-inch copper tubing.

Selecting the Best Alloy May Involve a Compromise

Selection of copper and copper alloys for electrical or thermal applications frequently involves a compromise among the various characteristics required. Electrical and thermal conductivity of unalloyed copper is, of course, superior to that of the alloys; the addition of other metals always results in a lowering of conductivity. The nature of the application, however, may make other characteristics more important than conductivity.

In the electrical field, copper is the standard for indoor wiring, motor and generator windings, and for the general run of application. In exposed outdoor wiring, encountered in railroad and trolley-bus service, conductivity may be sacrificed to some degree in the interests of tensile strength and wear resistance.

In thermal applications—condensers and heat exchangers—long tube life is the basic factor in metal selection. The savings in maintenance costs with a properly chosen alloy far outweigh the reduction in thermal conductivity. Local conditions, which vary widely, require alloys of different composition in order to resist corrosive attack.

Directional Properties in Rolled Brass Strip

Investigation of the characteristics of brass strip which has been cold rolled shows that the brass develops directional properties when a large rolling reduction is made between the last two annealing operations.

As marked directional properties may be a serious disadvantage in many applications, it is desirable, for such applications, to limit the amount of reduction in the last rolling operation, even if this limitation requires an additional rolling to bring the sheet to the proper finished dimension. The last two annealings and the rolling which takes place between them control the extent of the directional properties.

Directional properties manifest themselves in several ways. If the rolling reduction is large, variations will be found in both tensile strength and ductility. The tensile strength is greatest and the ductility is least along the normal to the rolling direction; parallel to the rolling direction the converse is true. Cupping operations show a tendency to develop ears when the strip has directional properties.

Control of annealing and rolling operations permit manufacture of brass strip in which the extent of directional properties is limited to fit the application.

BRASS TERMINOLOGY

This is the eighth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys, and the second devoted to the subject of hardness and grain sizes.

Temper or Degrees of Hardness

As pointed out in a previous article, the percentage of reduction in area during a rolling or drawing operation is a measure of the hardness of copper and its alloys. The terms quarter hard, half hard, etc., were seen to have definite meanings in the case of sheet.

An entirely different situation arises in the case of tube, rod, and wire. Here such terms as quarter hard, half hard, and hard are not sufficiently definite in meaning to serve as adequate specifications.

Rod and Wire Tempers

When rod or wire is drawn to a smaller diameter, the reduction in area is, of course, not proportional to the reduction in diameter. The cross-section areas of the rod or wire before and after drawing are proportional to the squares of the corresponding diameters. The degree of hardness of rod or wire is best expressed in terms of the actual percentage of reduction in area. This method of specification is definite and precise. If a rod or wire is drawn until the area has been reduced 10%, the metal is said to be drawn 10%.

Occasionally the hardness of wire is specified in terms of numbers reduction on the B. & S. scale. As a reduction of a given number of numbers on the scale always produces the same reduction in area, this method of designation has a definite meaning. It must be noted, however, that a wire two numbers hard is harder than sheet two numbers hard, because in the case of wire a greater reduction in area is made.

Tube Tempers

In the case of tube, the outside diameter and the thickness of the wall both change during the drawing operation. Here the reduction in area expressed in terms of per cent is the only specific and definite measure of hardness.

It will readily be seen that the terms quarter hard, half hard, etc., are best confined to sheet. For rod, wire, and tube, the hardness is preferably designated in terms of per cent reduction in area.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,** for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers; oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

BRASS "Bridgeport" CU

Established 1865

COPPER WATER TUBE AND FITTINGS—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

*Trade-name.

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

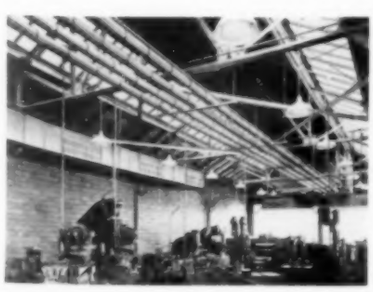
FEBRUARY — "Bridgeport" BRASS CO. — 1938

COPPER WATER TUBING CUTS INDUSTRIAL PIPING COSTS

Copper water tubing, low in both installation and maintenance costs, is rapidly gaining in favor for general industrial piping applications. Its advantages in water lines have long been recognized, and it is now being used in increasing quantities in the installation of the compressed air lines which are practically indispensable in almost all types of modern plants.

Easily installed with solder type fittings, copper water tube provides an economical, corrosion-resisting line for water or air. The desirability of a non-rusting line for water service is obvious; less apparent, but equally important, is the need of a non-corrosive system for compressed air. Moisture may readily cause rusting of materials with inadequate resistance. The results are high maintenance costs and the presence in the air of foreign matter, as the flow of air in the piping system tends to detach the rust and carry it to the outlet. Copper water tube's freedom from rusting insures a cleaner supply of air.

Another prime factor in the popularity of copper water tube is the high percentage of the original investment which can be recovered when plant conditions make necessary the dismantling or rearrangement of the original installation. The use of solder type fittings makes the dismantling of copper water tube as easy as the assembly. Neither tube nor fittings are destroyed in the process. If it becomes necessary to discard the original installation, the tube and fittings have a high scrap value.



Copper water tube, quickly and economically installed with solder type fittings, is coming into more general use for industrial piping service for either water or air. Resistant to corrosion, easily adaptable to changing plant conditions, and having a high scrap value, it is a valuable aid in reducing maintenance costs.

COMPREHENSIVE STUDY OF SILICON BRONZES IS CONTAINED IN NEW DURONZE MANUAL

Eighty-Page Handbook Discusses Fabrication and Applications of Silicon Bronzes; Gives Technical Data on Four Duronze Alloys

Comprehensive information of value to every manufacturer and user of specialized metal products is contained in the "Duronze Manual," a new eighty-page book recently released for distribution.

The booklet discusses in full detail the characteristics of the group of silicon bronzes which are manufactured by Bridgeport Brass Company under the name of Duronze*. These bronzes, the result of intensive metallurgical research and careful study of the specific requirements of many industries having unusual fabrication or application problems, represent one of the most important developments of recent years in the non-ferrous field.

Four Alloys Differ Widely

While possessing the common feature of a high copper silicon composition, the four alloys which compose the Duronze group differ widely in their physical characteristics, methods of working and fabrication, and specific fields of application. The ever-broadening range of industrial demands necessitates a similar widening of the range of alloys available. The various Duronze alloys were engineered with a view to supplying industry with a selection of metals capable of withstanding unusually severe conditions.

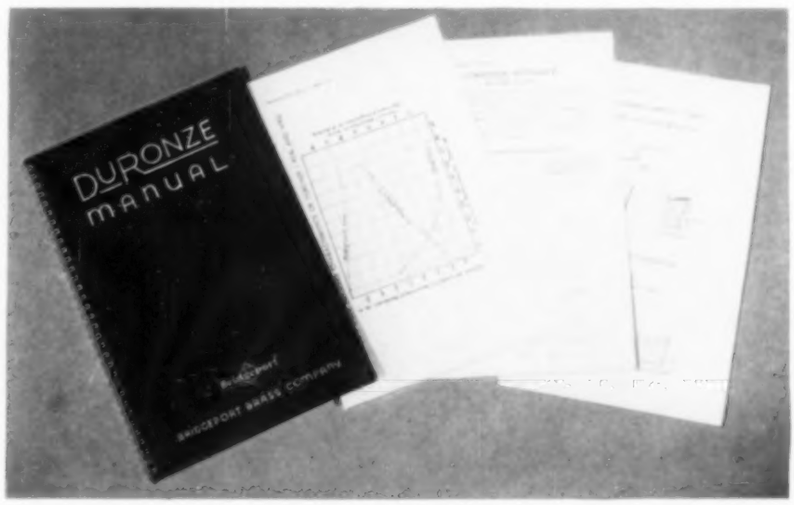
The actual selection of an alloy for a specific application can be made with the greatest assurance of success if the purchaser refers his problem to a competent

(Continued on following page, column 2)

To New Readers

Appearing every month, the COPPER ALLOY BULLETIN presents two pages of news of significant developments in the field of copper and copper-base alloys. Copies of previous issues of the Bulletin may be secured by writing to the Bridgeport Brass Company.

A special four-page edition of the Bulletin, containing additional tables and information, is available to supplement the copies appearing in this publication. Readers desiring to receive the four-page edition may have their names added to the mailing list. A note on your company letterhead is all that is necessary.



PREPARED EACH MONTH BY THE BRIDGEPORT BRASS COMPANY

Headquarters for Brass, Bronze and Copper

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A new cable connector is made in three sections which fit together and are held in place by screws. This arrangement is said to permit the use of one connector for several different cable sizes. The connectors are available in a range from No. 8 solid wire to 2,000,000 cm. cable.

Pipe vises are equipped with chains and locking handles for attachment to vertical posts or columns. The chain hooks into a slotted cup, and the handle tightens the unit into place. Available in two types: open side, for pipe from ⅛ to 2 inches; and hinged post, for pipe from ⅛ to 2½ inches.

A copper alloy strip is reported to give smoother and more uniform movement to a new thermostat. The strip is introduced as a third element between the customary two elements. The alloy strip is said to respond first to temperature changes and to increase the speed of operation of the thermostat.

A portable hardness tester has been developed for making field tests. It is said to be especially suitable for testing welds in locations removed from regular testing equipment. The complete outfit, which weighs only 6½ pounds, includes microscope for accurate measurements.

A metal cutting band saw is said to be suitable for a wide range of cutting operations. The saw is of 14-inch capacity, and will cut metals in thicknesses up to 6 inches. The saw has four speeds for metal cutting. It can be used for templates, jig and fixture bases, sheet metal sawing and many other applications.

A cartridge-type heating unit for use where a spot of heat is required within a limited space is designed for temperatures up to 750 degrees F. Available in ratings of 30, 75 and 90 watts for 115 or 230 volts. Unit is furnished with brass sheath.

An arc welder with plug-in control panel has a rating of 250 amperes, with a range from 25 amperes to maximum in 10 steps. It operates on 220 or 440 volts, 50 or 60 cycles, and takes rods up to ¼ inch.

NEW DURONZE MANUAL

(Continued from preceding page, column 3)

metallurgist. No booklet can serve as an adequate substitute for the advice and cooperation of a highly skilled metallurgical staff. But to the user of non-ferrous alloys the "Duronze Manual" will provide a wealth of information.

After a brief outline of the subject of silicon bronzes in general, the booklet proceeds to discuss in full detail the characteristics of the specific alloys, known as Duronze I, II, III, and IV. A concise statement of the basic properties of the individual alloys aids the reader in determining which of the four best suits his specific needs.

Particularly interesting to the fabricator of copper alloys is a section giving data on methods of working and on the design of suitable tools. Welding procedure, lathe speeds, and screw machine practice are among the topics discussed.

Other sections take up a wide range of specific applications in which the Duronze alloys have proved their worth in actual practice. Tables of technical data give physical properties and resistance to a number of the more common corroding agents.

Copies of the "Duronze Manual" may be obtained without charge by writing on company stationery to the Bridgeport Brass Company.

New Bronze Welding Process

Important advances in methods of bronze welding are reported with a recently introduced process. The method depends for its effectiveness upon the use of a liquid flux which is introduced directly into the gas line. The flux is carried to the torch tip and flows onto the point of weld along with the flame.

The developer of the process reports that an unusually clean weld is obtained, and the necessity for pickling is eliminated.

New District Offices

In order to provide better distribution facilities and service to its customers, Bridgeport has recently opened three new branch offices at the following locations:

Atlanta, Ga.....701 Volunteer Building
Milwaukee, Wis....715 N. Van Buren St.
Pittsburgh, Pa.....1319 Gulf Building

BRASS TERMINOLOGY

This is the ninth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys, and the third devoted to the subject of hardness and softness, i.e., temper.

Previous articles in this series discussed the meaning of terms used in specifying the degree of hardness of copper and its alloys. All of these terms refer to hard metal. In specifying the degree of anneal of a soft metal (softness, ductility, malleability), a different terminology must be used.

The terms "light anneal," "dead soft," and similar expressions are too vague to serve as specifications in ordering metal. The temperature to which the metal is heated is also an inadequate measure of the degree of anneal, because many other factors are involved.

Grain Size Is Best Measure

The size of grain is the most specific measure of the degree of anneal. A metal annealed at a low temperature has a fine grain; one annealed at a high temperature has a coarse grain.

The size of grain designates the actual average diameter of the grains, expressed as decimal fractions of a millimeter. If the grain size of a metal is said to be .020 mm. the metal consists of a mass of crystals, the average diameter of which, as revealed on the etched surface of a polished section, is .020 mm.

A fine-grained metal, produced by a low-temperature anneal, is stiffer and stronger than a coarse-grained metal. Other properties are the ability to withstand a certain amount of press work, and a very smooth surface after forming.

The coarse-grained metal is softer and will withstand more severe operations at the press, especially on heavy-gauged metal. After forming, it has a rougher surface than the fine-grained.

It will be noted that it is not possible to obtain the smooth surface of the fine grain simultaneously with the working qualities of the coarse. The grain size used is frequently the best possible compromise between two mutually exclusive qualities.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,** for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers; oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS CO. *Established 1865*

COPPER WATER TUBE AND FITTINGS—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

*Trade-name.

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

MARCH — "Bridgeport" BRASS CO. — 1938

COMPOSITION AND TEMPER DETERMINE BEND RADII

The degree of temper and the chemical composition of a non-ferrous metal or alloy are important limiting factors in the permissible radii of bends used in forming operations.

If the radius of bend is too sharp, the severe stretching of the outer fibers of the metal may result in a rough surface, and in exceptional cases may cause actual cracking. The direction of the bend with relation to direction of rolling also affects the radius. A sheet of D phosphor bronze 4 numbers hard requires a radius of 1/32 inch for a 90-degree bend perpendicular to the direction of rolling; if the bend is parallel to the direction of rolling, a radius of 7/32 inch is required. For sheet 8 numbers hard the corresponding figures are 1/16 inch and at least $^1/_4$ inch.

Because of the many variable factors involved, fabricators of brass can best be assured of satisfactory results if their complete problems are referred to competent metallurgists. Bridgeport is in a position to assist its customers in questions involving selection of alloys and methods of fabrication.

COPPER-BASE ALLOYS SMOOTH THE WAY TO PRODUCT ACCEPTANCE AT LOW COST

Manufacturers, Looking for Increased Sales Features, Choose Brass, Bronze, and Copper for Long Life

Manufacturers of metal products, on the alert for materials which will result in greater customer satisfaction without marked increase in costs, are finding in a wider use of brass, bronze, and copper a way to longer product life.

Growing emphasis on quality in a highly competitive market requires careful selection of materials. Because of their resistance to corrosion, the copper-base alloys have won wide acceptance for outdoor use and for applications subject to corrosive action.

Because of their ease of fabrication they permit the manufacturer to maintain high quality without excessive production costs. The substitution of copper-base alloys for other metals often results in greater profits, either through increased sales volume or through more economical production.

All Factors Must Be Considered

In any application the service requirements of the product must be weighed with the cost of production. It is on this basis that the copper-base alloys prove their value. A few typical examples serve as illustration:

Brass parts, used as a foundation for chromium-over-nickel plating, lengthen plate life, and will not rust when the plate wears off.

Thin sheet brass, which can be fabricated very easily, may be substituted for die-casting metal in many small parts. The brass is stronger and stands up where the white metal breaks off or corrodes rapidly from moisture and atmosphere.

Duronze*, combining the strength of steel and the corrosion-resistance of copper, has been found to meet exacting service requirements as easily as metals higher in price or more difficult to fabricate. Electrical and refrigerator parts are typical uses.

In these and many other cases manufacturers have found marked advantages in the use of brass, bronze, and copper. Because metal characteristics must vary to meet service and fabrication requirements, Bridgeport engineers cooperate with manufacturers of metal products in the selection of the alloy that will give greatest customer satisfaction at lowest cost.

MINES BUREAU EXPANDS RESEARCH

New experiment stations opened or enlarged in the last two years by the Federal Bureau of Mines are expected to facilitate the process of chemical and metallurgical research. An interesting project, already under way, is the study of the effect upon boilers of various constituents of water. A considerable portion of the research work is devoted to a study of the conditions under which intercrystalline cracking takes place.

Copper and Brass Research Association

● Illustrated are some of the many miscellaneous household items which are fabricated entirely from copper and copper-base alloys, or in which these metals form an important part of the finished product. Because of the widely varying physical characteristics which can be obtained by selecting the proper alloy and temper, the copper alloys readily lend themselves economically to almost every fabricating process—cutting, forming, punching, welding, plating.

PREPARED EACH MONTH BY THE BRIDGEPORT BRASS COMPANY

Headquarters for Brass, Bronze and Copper

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A rinsing nozzle for use in plating and finishing shops is reported to give more rapid and thorough rinsing than is possible with a water bath. The nozzles produce a center jet spray and are furnished in sizes to accommodate available water pressure. They are easily installed in existing water rinsing tanks.

Tankless water heaters are now available in sizes reported to be large enough for industrial applications. Water is heated in a continuous seamless copper tubing, insuring freedom from rust. The units are small and compact, and function on automatically fired boilers.

Sheet metal cutters can be used to follow a straight or irregular outline. It is reported that no backing is required for the metal during the cutting operation. Smaller size is suitable for metals of 22 gauge or smaller; larger size handles up to 16 gauge.

A new flux for brazing and hard soldering is ready for the market. It is reported to have a lower melting point than most hard solders now on the market, and to permit the operator to begin work as soon as the solder starts to flow. It is suitable for use with copper, brass, bronze, and many other metals.

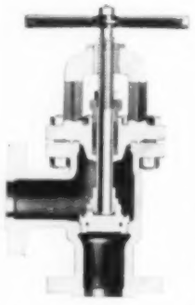
An unwinding reel is designed to handle coils of metal weighing up to 8,000 pounds. It is said to be suitable for light-gauge metal as well as heavy. It is also reported to be capable of handling bright-finished metal without marring or scratching the surface. The metal is automatically delivered at predetermined speed to roll feed press, slitter, or other fabricating machinery.

A line of polishing machines is available with motor ratings from 2 to 15 horsepower. The spindle is overhung 14 inches in front of the housing to provide adequate clearance for polishing large parts.

A portable welder for alternating current supply is especially designed for heavy service in industrial plants. Three open-circuit voltages are available: 80, 85, and 90. Current is variable from 10 amperes to maximum output, which ranges from 300 to 600 amperes, depending on the size of the unit. The unit is cooled by forced air circulation.

A precision lathe is reported to be adapted to the accurate machining of very small diameter parts of brass, bronze and other metals. Spindle speeds range from 40 to 1,200 RPM. The lathe is equipped to cut threads from 4 to 112 per inch, and has power longitudinal feeds of .002 to .015 inch per revolution of the spindle.

HIGH STEAM TEMPERATURES DEVELOP NEW DURONZE USE



The trend to higher steam temperatures and pressures in generating stations has resulted in a new application for Duronze* III in the thread bushing material for blow-off valves.

In generating stations being built today, steam temperatures of 950 degrees F. are not uncommon, and in some cases the temperatures are as high as 1000 degrees. Confronted with the necessity of constructing trouble-free blow-off valves for these higher temperatures, Hancock Valve Division of Manning, Maxwell and Moore, Inc., began a systematic search for a thread bushing material with the proper characteristics.

In cooperation with a large Middle Western public utility, which was operating at high steam temperatures, Hancock conducted a series of tests on various materials. As a result of these tests, Duronze III was selected as the standard thread bushing material for all Hancock Valves for steam service.

In order to obtain a true picture of the relative suitability of the various metals, tests were carried on over a long period of time and under exacting conditions. In this way actual operating practice was simulated as nearly as possible. After hundreds of operations of the valve without any lubrication during the testing process, the Duronze thread bushing showed practically no signs of wear. Its performance under these conditions is an indication of the low coefficient of friction characteristic of Duronze III.

Bolt heading machines are made in seven standard sizes. The smallest, for $\frac{1}{2}$-inch stock, has a capacity of 100 to 125 pieces a minute; the largest will handle $1\frac{1}{2}$-inch stock at the rate of 35 pieces a minute. The cut-off bar is supported so that the knife is held flush with the face of the cut-off die.

BRASS TERMINOLOGY

This is the tenth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys, and the fourth devoted to the subject of hardness and softness, i.e., temper.

In concluding the discussion of temper, it is advisable to clarify the meaning of the term "relief anneal." This term has a specific meaning, but it has been misused so frequently that its true significance is in danger of being lost.

When a piece of metal is cold rolled, drawn, stamped, or formed, it is hardened by the operation. This hardening may, and probably will, set up internal stresses. By heat treatment at relatively low temperatures, it is possible to remove, or at least greatly reduce, these stresses without softening the metal in the slightest degree. Such a heat treatment is called a "relief anneal", because its purpose is merely to relieve stresses and not to soften the metal. In fact, under some circumstances, a slight hardening may result.

Relief Anneal vs. Light Anneal

A true relief anneal requires very delicate control of the process. If the treatment is insufficient, the stresses may not be adequately relieved; if it is excessive, actual softening of the metal results. In many cases a very slight softening of the metal is not a disadvantage, while a failure to relieve stresses may be serious. For this reason it frequently happens that metal undergoing a relief anneal is softened slightly as a safety measure. The slight softening is proof that the stresses have been adequately relieved.

If the annealing process has for its primary purpose the actual softening of the metal, the term "relief anneal" should not be used. Such an anneal is a "light anneal", and its exact degree should be specified in accordance with the terminology indicated in previous articles in this series.

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BRASS "Bridgeport" CO.

Established 1865

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BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

APRIL "Bridgeport" BRASS CO. 1938

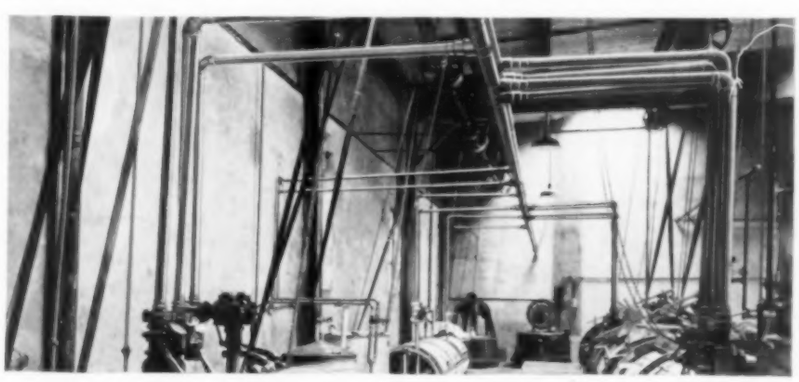
LAUNDRY PIPING TYPIFIES COPPER TUBE ADVANTAGES

Typical of the advantages of copper water tube for general industrial piping applications is the installation at the Park City Laundry Co., Bridgeport, Conn. Here the iron and steel piping which had previously been used was completely scrapped, and replaced by Bridgeport Type "K" Copper Water Tube and Bridgeport Arco Solder Type Fittings.

Because of the non-rusting qualities of copper water tube, discoloration of the water supply is eliminated—a vital factor in laundries, where a clean supply is absolutely essential in both the hot and cold water lines.

This rust-free system was completed at surprisingly low cost, made possible by using smaller sizes as copper piping does not clog with age. The solder type fittings help to keep the internal friction low, minimizing the reduction in water pressure. Another important advantage of the copper water tube is its ready adaptability to future equipment changes. The fittings can be easily unsoldered to permit rearrangement of lines or addition of new ones. Expansion of facilities, therefore, can be accomplished with the minimum expense.

The advantages of copper water tube in this laundry installation apply equally well to water, steam, and general-purpose piping in many industrial fields. Many manufacturing plants are modernizing their piping systems by substituting copper tube for rustable types of pipe.



Interior of the Park City Laundry Co., where Bridgeport Copper Water Tube has completely replaced the piping system previously used. Clean wash requires clean water.

NEW OPPORTUNITIES FOR COPPER ALLOYS IN DOMESTIC HARDWARE APPLICATIONS

Brass, Bronze and Copper Are Associated with Quality Construction in the Building Field

Copper and copper-base alloys, distinguished by their naturally colorful appearance, have been used in large quantities in recent years in the manufacture of giftware, utensils and a long line of ornamental accessories. The public's greater acquaintance with and acceptance for these metals offers an interesting "market opportunity" to the manufacturer of hardware, particularly in view of the low prices currently prevailing on the red metal. Widespread use of metal and emphasis on color are important aspects of today's trends in household design and interior decoration, and increased use of the warm, richly colored copper alloys is in keeping with this trend.

Equally important in the desirability of brass, bronze, and copper is their ability to withstand corrosive attack and to retain their original appearance unimpaired for long periods of time. From the standpoint of the manufacturer, ease of fabrication of the copper alloys allows low production costs—an important factor in meeting the competition of other materials.

Copper Alloys Suitable for Many Items

There are many applications for the copper alloys in domestic hardware—letter boxes, locks, door-knobs and bathroom fixtures being a few of the products for which brass and bronze are frequently used. Among the other household uses are weather-stripping, screen wire, window sash and roofing. Commercial bronze weather strip and screen wire have already won wide acceptance. Brass pipe has long been considered a necessity in a well-built house. Copper water tube, combining quality with economy, is finding ever greater application for plumbing, heating and oil lines. Hot water storage tanks made from

(Continued on following page, column 2)

220,000,000 Pounds of Copper in a Man-Made Mine

One of the richest copper deposits in the world is the man-made mine which the Consolidated Edison Company has buried under the streets of New York City. More than 220,000,000 pounds of pure copper were used in the installation of the company's 38,000 miles of underground cable. In the last ten years alone, the company has purchased 142,000,000 lbs. of the metal in the form of pre-fabricated materials.

Letter boxes, door-knobs and similar hardware, fabricated from brass or bronze, combine resistance to corrosion with rich color and attractive appearance.

The Yale and Towne Manufacturing Co.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A new rolling machine is reported to be especially useful in plants fabricating air conditioning and similar ducts from sheet metal. It is designed to form folded seams at high speed. Machine will handle metal up to 18 gage thickness at speeds as high as 38 feet per minute. Two sets of rolls are provided.

An arc welding machine is said to be suitable for use with electrodes from 1/16 to 5/16 inch in diameter. Transformer and control switches are assembled in a non-metallic housing. Twelve heat ranges are available, and adjustment is made by switches controlled from the top of the housing. Welding and ground cables are permanently connected through bushings in the housing wall. Operates on a.c. only.

A high-speed shear has a low cutting head reported to give great flexibility of operation in cutting formed pieces of sheet metal. It is useful for short runs or for large formed pieces, and eliminates the need of trimming dies.

A new saw for brass and other non-ferrous metals can be used with billets, bars, and tubes up to 9 inches in diameter. Sliding gear transmission provides cutting speeds of approximately 250, 370, 485, and 600 feet per minute. Feed can be varied from 0 to 100 inches per minute by a self-contained hydraulic unit. Adjustable stops provide automatic trip for the carriage motion in both directions.

A metal coating is said to protect against the formation of welding spatter. It can be applied to the metal surface by brushing, dipping, or spraying. The coating contains water, which cools the welding sparks as they hit the metal, preventing them from adhering. When the welding operation is completed, the coating can be easily cleaned off with hot water or a cleaning solution.

A cleaning machine carries work on a revolving table under a blast of abrasive grit or shot and returns the cleaned piece to the loading point at the front of the machine. It is said to be suitable for work which might be scratched or broken by a tumbling process. The degree of finish is controlled by the selection of the grit or shot. The design of the machine is such that the work is continuously rotated as it passes through the blast.

Chromium plating anodes are made from extruded lead in a sawtooth construction. It is reported that this design adds 50 per cent surface area as compared to a flat-faced design. Supporting hooks are integrally bonded to the lead to provide continuous metal contact.

HARDWARE APPLICATIONS

(Continued from preceding page, column 3)

Duronze® eliminate the rusty water problem. Copper roofing assures low maintenance plus fire protection.

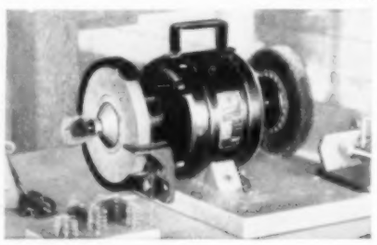
The wide range of available alloys permits selection to meet the requirements of both production and service. On special problems concerning which fabricators may desire metallurgical assistance, the engineering department of Bridgeport Brass Company will gladly offer technical advice and cooperation.

Portable Machine Speeds Work in Installation of Copper Tubing

The economy of a copper tubing installation is reported to be still further increased by a new portable machine.

The machine speeds up the preparation of the tubing for the soldering operation for joining it to fittings. Powered by a 1/4-horsepower motor, this handy little device includes a vise and saw guide for truing the ends of the tubing during the cutting operation, an emery wheel for removing the burr from the outside of the tube, and a reamer to smooth the interior surface.

Wells Tool Co.



A new metal finish is said to be suitable for products subjected to severe abrasion, chemicals, and cleaning soaps. Typical examples are domestic and office machinery. It is available in two spraying and two dipping qualities, and produces an extremely tough finish when baked.

BRASS TERMINOLOGY

This is the eleventh of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys, and the first devoted to the subject of gages.

The specification of sizes of wire and sheet is one of the most confused—and confusing—subjects in the entire field of metal nomenclature. The methods in use today are the outgrowth of earlier practices, some of which were completely illogical. While the meaning and scope of application of the various methods are well understood by the makers of metal, the metal user may find himself confronted by an apparently haphazard situation. In the effort to clarify the terms used, the next group of articles in this series will discuss methods of specifying wire diameter or sheet thickness.

Measuring Thickness

Two general methods are in use today. The first is to specify the dimensions in terms of thousandths of an inch. This method is growing in favor with the users of sheet and wire, and in many large companies all manufacturing specifications are expressed in these terms.

The second method is to specify the dimensions in terms of the *gage number* on a standard scale. In the early days of the metal industry many of these gages came into existence. In general, each of these gages was devised by a manufacturer for specifying the dimensions of his own products, and little effort was made to coordinate the dimensions on one scale with any of the others.

In 1887 a total of 30 gages were in existence, 19 of which were for wire. The development of the industry gradually reduced the number of scales in use to a few which best met requirements. In modern American practice, wire dimensions are usually specified on one of two gages. *The Brown & Sharpe Gage* (American Wire Gage) is standard for wire to be used for electrical purposes. Steel wires are generally specified on the *Steel Wire Gage*. The continued existence of these two gages is logically justified by the fact that the application requirements of the two classes of wires are very different.

The next article will discuss the construction of the B. & S. gage and the reasons for its widespread use.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,®* for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers; oil refineries, and process industries.

PHONO-ELECTRIC® ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE® ROD—For making automatic screw machine products.

BRASS "Bridgeport" CO. *Established 1865*

COPPER WATER TUBE AND FITTINGS—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"® for plumbing, underground and industrial services.

®Trade-name.

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

MAY — "Bridgeport" Brass Co. — 1938

BRONZE WELDING PROCESS GIVES SMOOTH JOINTS

Smooth welded joints, free from porosity, are reported to be the result of a bronze welding process used in conjunction with a recently developed liquid flux.

Designed for use in gas welding, the new method introduces the liquid flux directly into the gas line, and discharges it through the tip of the torch with the flame. Control of the amount of flux used is entirely automatic.

The process can be used for the brazing of non-ferrous metals to iron and steel, or for the welding of brass, bronze, and copper. Several important advantages are claimed. The liquid flux has a lower melting point than most powdered fluxes, permitting the operator to start the welding process at a lower temperature.

The Automatic Gasflux Co.

LEFT: Welded joint formed by ordinary methods of bronze welding. RIGHT: Weld formed by the Automatic Gasflux process.

Copper Rings Protect Pipes

An interesting application of the versatility of copper is seen in its use in the protection of clay and concrete sewer pipe from the damage caused by roots of trees and shrubs.

Rings formed of copper are inserted in the joints of the pipe. The copper, while not subject to destructive corrosion, forms the surface coating which is characteristic of the metal. This coating, while it protects the copper against further attack, has the property of preventing further growth of the roots which come in contact with it, thus effectively preventing them from damaging the pipe.

COLD HEADING PROCESS IS WELL ADAPTED TO MANUFACTURE OF STRONG DETAIL PARTS

High Tensile Strength, Economical Production Are Important Factors In Its use

The cold heading process of forming bolts, screws, compression nuts, and miscellaneous small parts is already in widespread use in many industries, and its potentialities are being explored by others.

The process has peculiar advantages for the economical production of hardware and similar parts requiring great strength. Depending for its efficacy upon the increase in tensile strength of a metal when subjected to cold working, it produces extremely strong pieces without the necessity for expensive operations.

The metal must be sufficiently malleable before working to prevent undue wear on the cold heading tools. It must be capable of withstanding severe forming operations without becoming brittle, for cold headed parts are used without subsequent heat treatment. These characteristics are necessary to insure cost economy and service reliability.

The reliability of cold headed parts for corrosive service conditions depends upon the characteristics of the alloy used. Typical uses are hardware for overhead electrification systems, automotive parts, and parts for refrigerators and water meters. As all of these applications encounter corrosive conditions, the metal requires a high degree of resistance to rust. Hardware with a tendency to rust quickly decreases in cross-section and consequently in total strength.

Brass, Duronze I Widely Used

Two metals which have been found especially suitable for cold heading operations are brass and Duronze* I. Both are malleable prior to working, and acquire high strength without brittleness in the forming process. Where corrosive conditions are not exceptionally severe, brass gives excellent results. For outdoor applications and other severe service conditions, Duronze I gives very high resistance to corrosion and season cracking. This metal, originally developed

(Continued on following page, column 2)

The cold heading process is ideally suited to the manufacture of parts requiring great tensile strength. Duronze I, widely used in cold heading, forms finished pieces with a tensile strength of 90,000 to 100,000 pounds and with high resistance to corrosion and season cracking.

Metal Spraying Finds Wider Applications

Industry finds many uses for the metal spraying process in the application of coatings to prepared surfaces. The method is used chiefly to provide a protective coating for surfaces which are subject to corrosive attack, and permits the utilization of the corrosion-resistant properties of the copper alloys on structures or parts formed from other metals.

A recently introduced spray gun is said to permit considerable improvement in the process. The atomized wire from the gun is deposited on the surface with sufficient impact to form a close bond. The resulting coating can be ground and polished when used on machine parts. Synchronized, fully automatic feed adapts the gun to a wide range of metals. When used with copper, it has a capacity of 18 pounds per hour.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A chip separator is reported to be suitable for removing chips from screw machine products after treatment in an oil separator. Chips and parts are dumped into a hopper and fed through a stream of air from a motor-driven blower. Chips are blown through a hood at one end of the machine; parts are discharged from a chute at the side.

A threading machine, semi-automatic in operation, drives four spindles, and will cut threads up to a maximum length of 3½ inches on studs or bolts from ¼ to ¾ inch in diameter. Movement of spindles and work grips are controlled by cams which are mounted on shafts driven by a gear train.

Piercing tools for holes from ⅛ to 3½ inches in diameter in sheet metal are furnished in a complete assembly including dies and punches, together with holders, stripper-plate adapters for the punches, and bushing adapters for the dies.

An etching liquid for brass and copper can be applied by means of a rubber stamp, and is said to give a permanent black finish. It dries rapidly in air without the application of heat.

A metal cutting torch is furnished with two mixers which adapt it for use with a variety of fuel gases. Acetylene, propane, butane, hydrogen, and manufactured or natural gas are some of the possible fuels. The torch is available with a 75- or 90-degree head and with lever or trigger arrangement.

New power drills for general utility service are available in ⅝, ¾, and ⅞-inch sizes. They are powered for heavy duty, such as drilling hard metals.

New type finishing machines are said to be especially suitable for small machine parts, novelties, and similar items. They will perform as many as three finishing operations and complete drying. Operation is automatic and continuous. Speed can be adjusted to provide proper drying time. Furnished in many different types and sizes for special needs.

A portable shear is furnished in 16 and 18-gage sizes. It will cut all types of metals on a radius as small as ¾-inch, and can be used beyond its rated capacity on copper and other non-ferrous metals.

A new rectifier for electroplating service is of the copper oxide plate type. It is built in a wide range of sizes, and is reported to have high power factor and low installation cost.

A portable welder for A. C. service is available in four models, with maximum ratings from 300 to 600 amperes. Open circuit voltages are 80, 85, and 90; higher voltages can be supplied if desired. Current range is adjustable from 10 amperes to maximum by knife switch control.

COLD HEADED PARTS

(Continued from preceding page, column 3)

for overhead catenary construction, has a tensile strength of approximately 43,000 pounds per square inch in the annealed state, and is remarkably malleable even when hard drawn. When it is cold worked, the tensile strength rises to 90,000 to 100,000 pounds per square inch, compared to about 70,000 pounds for ordinary steel parts.

Manufacturers whose products require strong, corrosion-resisting hardware, may find in the cold heading process a satisfactory method of forming dependable parts. Bridgeport engineers will advise in the selection of a suitable metal for the service conditions encountered.

Phosphor Bronze Qualities In Mechanical Applications

The unusual spring qualities of phosphor bronze, which, together with its high conductivity, have caused it to be selected for many electrical applications, make it equally suitable for the fabrication of many parts designed for strictly mechanical operation. This alloy retains its original resilience unimpaired over long periods of time—a vitally important factor in the satisfactory operation of any spring-controlled mechanism.

Phosphor bronze possesses the additional advantage, which it shares with the other copper alloys, of a high degree of resistance to the corrosive effects of moisture. The life of the metal is, therefore, not shortened by the effects of rust.

In the form of wire, phosphor bronze is widely used in the manufacture of coiled springs for a host of miscellaneous applications. In sheet form it is ideally adapted for the fabrication of bellows for valves and similar mechanisms. Here its ability to resist the effects of dampness is especially important, as valves are, of course, most commonly located on steam or water lines, and are constantly subjected to the effects of moisture.

BRASS TERMINOLOGY

This is the twelfth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys, and the second devoted to the subject of gages.

The Brown & Sharpe Gage

The gage which is known as either the Brown & Sharpe Gage or the American Wire Gage (commonly abbreviated to B&S and AWG) was first devised by J. R. Brown of the Brown & Sharpe Manufacturing Co., in 1857. The logical basis of this gage system quickly led to its widespread acceptance, and it soon superseded the Birmingham Wire Gage, previously in use. Today the B & S Gage is universally used in American practice for the specification of all wire for electrical purposes, and is also frequently employed in specifying the thickness of sheet.

Constant Ratio of Dimensions

In the B & S Gage the ratio of any wire diameter or sheet thickness to the next number is the constant 1.1229322. For wires the ratio of the areas of consecutive numbers is 1.261. Because of this constant ratio of dimensions, certain relationships occur over every part of the scale. For a difference of three numbers the electrical conductivity is always halved. A No. 13 wire, for example, has half the conductivity of a No. 10, and No. 16 half that of No. 13. (This corresponds to halving the area.) The diameter is halved every six numbers.

No. 10 on this gage presents several interesting features, which serve to fix its characteristics in mind. The approximate diameter of a No. 10 wire is .1 inch. (The exact figure is .1019.) The resistance of the wire, measured at 20 degrees C., is very nearly 1 ohm per 1,000 feet. The cross-section is about 10,000 circular mils.

When it is realized that many of the gages in earlier use were arbitrary and illogical in the relationship between different numbers on the scale, the immediate success of the B & S system is readily understood. It gave to both the makers and users of wire and sheet a consistent, logical basis for specifying dimensions. The constant relationship of electrical conductivity makes it especially suitable to the needs of the electrical industry.

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BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

JUNE "Bridgeport" BRASS 1938

SILICON BRONZES OFFER MANY POSSIBILITIES

The silicon bronzes, such as the Duronze* alloys manufactured by Bridgeport, offer interesting possibilities for the fabrication of parts and equipment subjected to the action of corrosive liquids or fumes.

Because of the ease with which it can be fabricated into shapes ranging from small hardware to complete tanks, Duronze II is readily applied in many types of service which require high strength and corrosion resistance.

A special advantage of Duronze II is that complete structures can be fabricated without the introduction of dissimilar metals which might give rise to galvanic action in contact with an electrolyte. Hardware used in the equipment can be formed from Duronze II rod and wire by the hot forging process. Where welded construction is employed, Duronze II can be welded with Bridgeport No. 1232 Silicon Bronze welding rod. This rod is the same as Duronze II in composition.

While all of the Duronze alloys are distinguished by their superior corrosion resistance, the actual results obtained when they are used in contact with a specific corrosive agent can best be determined by test. Bridgeport will gladly furnish samples of these alloys for test purposes.

Copper Trees in Model Forest

Copper models, made exactly to scale, are used at the Harvard Forest (a division of Harvard University) to illustrate forest history and modern forestry practice.

The trees are built up of fine copper wire and show the characteristics by which the various species are identified. The leaves or

pine needles are formed of sheet copper. Each unit is attached to a wire, and the separate units are assembled to form boughs.

The illustration, reproduced through the courtesy of the Harvard Forest, represents a hardwood forest about the year 1930.

HOT FORGINGS MADE FROM COPPER ALLOYS MEET MODERN ENGINEERING REQUIREMENTS

Ease of Manufacture, Physical Properties Factors in Use

Engineers, aware of the versatility of the copper alloys, are using increasing quantities in the manufacture of parts by the hot forging process. Ease of fabrication and excellent physical properties are the chief reasons for wider use.

Of the copper alloys, special forging brass is the easiest to hot forge, because it flows readily at a reasonably low temperature (indicated by cherry red heat). Duronze* III, a silicon aluminum bronze, also forges easily compared to copper and the high copper bronzes, such as Duronze I and II, which are stiffer when hot.

The hot forging process has marked advantages. The metal, softened by the forging temperature, can be formed with much less effort than is required for cold heading. For heavy-walled parts that must have high strength, hot forgings are displacing bulkier but weaker sand castings. Hot forgings are generally more than twice as strong as castings, freer from porosity, more precise in dimensions, and have smooth, clean surfaces, easy to polish and plate.

As forgings require special tools made from heat-resisting steel, the process can be economically used only for quantity production. This limitation, however, is not serious in view of the great number of items made on a mass production basis.

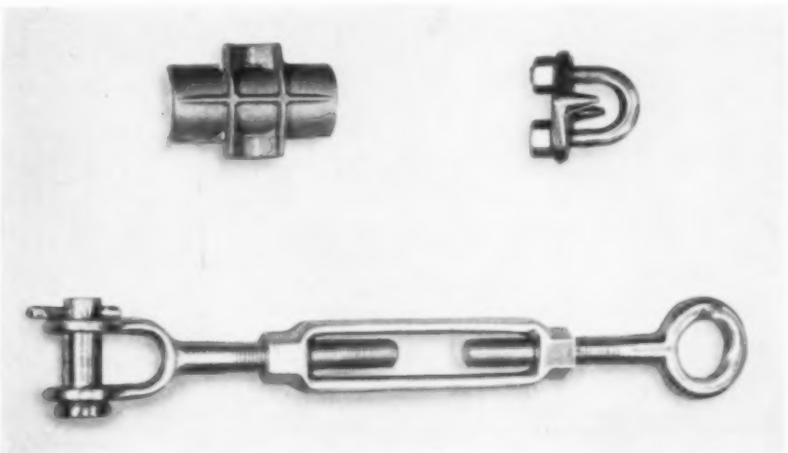
Bridgeport Forging Rod is a special alloy developed after years of experimentation to meet the requirements of the hot forging process. Highly plastic when red hot, it fills the dies easily. This rod also possesses the advantage of being free machining. Brass forgings are used for building hardware, refrigerator parts, valve parts, and many other items.

Duronze Forgings

Duronze II forgings are recommended for outdoor construction where brass is not satisfactory. With approximately the same strength as brass forgings, they have high resistance to corrosion and season cracking. Ideal applications are in the manufacture of pole line hardware and marine hardware. This alloy is not free machining.

Duronze III Rod is one of the most suitable alloys for hot forging. Essentially a silicon bronze, it is harder and stronger than brass or copper. It forges at a slightly higher temperature than brass and readily fills the dies. Duronze III hot forgings have a Brinnell hardness number of about B-90

(Continued on following page, Column 2)



Strong, non-corroding parts for outdoor service are readily hot forged from Duronze II and III.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A cold heading machine is suitable for the production of screw blanks and other headed parts. It is furnished for either belt drive or individual motor drive. It is built in two sizes; the 3/16-inch machine handles work up to 1 inch long at the rate of 225 pieces per minute, and the 1/4-inch size handles work up to 1½ inches long at the rate of 175 pieces a minute. The machine is of the double-stroke type.

Buffing and polishing machines are designed to permit the attachment of exhaust equipment, and are said to be suitable for use when machines are so located that they cannot be connected to the regular exhaust system. The machines are of the pedestal type, and the exhaust blower and its driving motor are mounted on a common base and attached to the back of the pedestal. Sizes of machines range from 1 to 20 horsepower.

A twin hose for gas welding is made in 1/4, 5/16, and 3/8-inch sizes. The hose consists of two separate passages, one for acetylene and one for oxygen, joined by an integrally molded web. Working pressures can be as high as 200 pounds per sq. in. Different colors are used to differentiate the two passages.

A grinding machine will handle work measuring up to 18 by 6 inches in surface dimensions. Heights up to 9½ inches can be accommodated under the grinding wheel. The machine is supplied for operation by belt drive at a speed of 3,200 R.P.M.

A cradle reel is reported to be suitable for coils of stock of light and medium thickness for use with punch presses. The reel is so designed that it unwinds from the coil a loop of a size determined by a roller control arm. This arm starts and stops the driving motor of the reel. It is said that this arrangement gives more accurate feed than when the stock is taken directly from a coil. Plates revolving with the stock protect the edges.

A new hydraulic punch weighs less than 14 pounds, and can be easily moved from one location to another. The machine performs punching, trimming, or notching operations on almost any shape of formed metal, and takes standard punch and die sets.

A portable hacksaw incorporates a new movement which automatically determines the pressure necessary to cut metals of different degrees of hardness. The cutting movement is said to be sufficiently free from vibration to eliminate chatter marks. Thin tubing can be cut without bruising or tearing. The saw will handle square or round stock up to 7 inches.

HOT FORGINGS

(Continued from preceding page, column 3)

and a tensile strength ranging from 85,000 to 90,000 pounds per square inch, depending on cross-section and forging temperature. This alloy is free machining, and can be cut at about 70 per cent of the speed of free cutting brass rod.

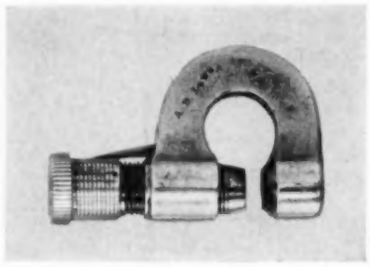
Duronze III is used chiefly for wire and cable connector parts. Nuts made from this alloy can be used repeatedly without distorting. It is used in valve parts also.

Manufacturers are invited to discuss their forging problems with Bridgeport Brass Company.

The First Micrometer Gage

In the early days of the brass industry, crude measuring instruments caused constant confusion.

In 1867, S. R. Wilmot, then Superintendent of the Bridgeport Brass Company, conceived an idea for a new and accurate type of measuring instrument. Under the direction of A. D. Laws, head of the Mechanical Department, six instruments were built in accordance with Mr. Wilmot's idea. These instruments—products of the Bridgeport shops—were the first micrometer calipers ever built in America.



The first micrometer gage

These early models were brought to the attention of Joseph Brown and Lucian Sharpe, who quickly recognized the possibilities of the instrument. Invented by Bridgeport to fill a dire need, the device set the general style for the standard measuring device of today.

BRASS TERMINOLOGY

This is the thirteenth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys, and the third devoted to the subject of gages.

As pointed out in last month's column, the AWG or B & S Gage is very widely used in the non-ferrous industry for specifying the dimensions of wire and sheet. A great number of other methods, however, are also used either for special purposes or for specific metals.

In the case of wire, there are few exceptions to the use of the B & S Gage in the non-ferrous industry. The Birmingham Wire Gage, formerly used in this country but now largely superseded by the B & S, is still retained to some extent in specifying wire for telephone and telegraph use, and by the Treasury Department in calculating import duties. The Old English or London Gage, also formerly used for brass and copper wire, is now nearly obsolete, except in specifying brass wire for weaving. (These two gages will be discussed more fully in a later issue.)

Non-Ferrous Sheet Gages

There is much less uniformity in the specifying of non-ferrous sheet. The copper and brass industry largely employs the B & S Gage for sheet as well as for wire, but other methods exist, particularly in the case of copper. Copper sheets may be specified in terms of the weight of the sheet in ounces per square foot. As the weight per square foot depends on the thickness, the higher gage numbers with this method of specification obviously correspond to the thicker sheets—the reverse of the order of progression in the B & S scale. Copper sheet is also specified in thicknesses expressed in terms of sixteenths of an inch, in a range from $^1/_{16}$ to 2 inches. The Birmingham Wire Gage retains a very limited use for specifying copper sheet.

Copper and bronze for range boilers may be specified in terms of the United States Standard Sheet-metal Gage, possibly because they are used to replace galvanized iron. The Birmingham Wire Gage is employed also in specifying the wall thickness of boiler and condenser tubes and of miscellaneous brass, bronze, and copper tubing.

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BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

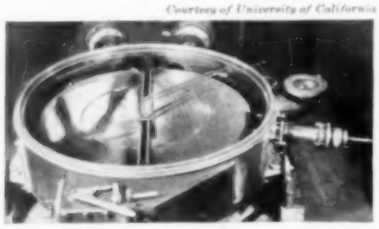
JULY — "Bridgeport" Brass Co. — 1938

COPPER PLAYS ITS PART IN SMASHING THE ATOM

Copper and its alloys play an important part in the construction of the new giant cyclotron—the "atom smasher"—at the University of California, where Dr. Lawrence and his associates have already performed amazing feats of modern magic with the 85-ton cyclotron now in use.

In the cyclotron the atoms are smashed by bombarding them into deuterons—nuclei of heavy hydrogen—traveling at terrific speed. Essentially, the device consists of a shallow vacuum chamber containing two high-voltage electrodes and placed between the poles of a powerful magnet. The vacuum chamber is pumped out, and a rapidly alternating potential of 50,000 volts maintained between the two electrodes,

Courtesy of University of California



The vacuum chamber of a cyclotron, in which the deuterons are prepared for the bombardment of the atom. A new cyclotron, of greatly increased size, is under construction at the University of California.

while a stream of electrons from a filament in the chamber ionizes the atoms of heavy hydrogen, converting them into deuterons. Under the combined effects of the attraction of the electrodes and the powerful magnetic field, the deuterons attain tremendous speed, gradually approaching the rim of the chamber. They are guided through a thin metal window out into the air, to strike whatever "target" may be in their path.

Any one of the 92 chemical elements may be used as a target and it is found that most of these elements become strongly radioactive during the bombardment. In other words, they acquire the mysterious property, which belongs only to radium and a few other rare elements, of expelling electrons with speeds close to that of light. For example, if table salt is bombarded by the deuterons, its sodium content is rendered radioactive, and the fast electrons may be detected individually by sensitive amplifiers.

If a person drinks a solution of this radioactive, but harmless salt, the paths of the individual atoms can be traced out by placing the amplifier at various places near the body. It is as though each sodium atom which was imbibed had a "red tag" on it to distinguish it from all the others normally present in the system. In addition to this use as "tracers", these new forms of matter have obvious clinical uses similar to those of costly, natural radium.

The cyclotron now under construction will use a 220-ton magnet, and will open to science even broader fields of investigation. Tons of copper are being used in the construction of the device. Among the copper materials which are being used in the building of this epoch-making device are copper water tube of high conductivity, made from oxygen-free copper, for high frequency circuits and Bridgeport Duronze* bolts for holding the large copper field coils around the huge magnet poles.

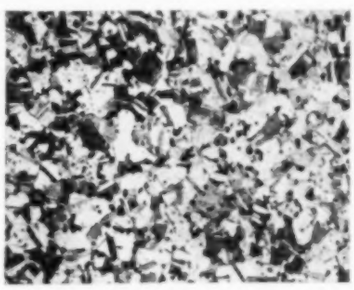
FREE CUTTING COPPER ALLOYS INCREASE AUTOMATIC SCREW MACHINE SPEEDS

Economical Production Combined with High Corrosion Resistance

The automatic screw machine—specifically a tool for high-speed quantity production of detail parts—depends for its effectiveness on the use of an alloy which permits the fastest operation consistent with the necessary physical properties in the finished product. Manufacturers of automatic screw machine parts find in the free cutting copper alloys metals ideally suited to their purpose.

"Ledrite" Free Cutting Brass Rod

From the standpoint of production speed,



Microphotograph showing transverse section of Ledrite rod.

the most suitable of the copper alloys is the one designated as free cutting brass rod, conforming to A.S.T.M. Specification B 16-29. Typical of these alloys is Ledrite* Rod, developed by Bridgeport specifically for automatic screw machine work. Actual tests conducted on screw machines have demonstrated that the machinability of Ledrite is superior to ordinary rods.

To the user of brass rod, an important consideration is the uniformity which he can expect in successive shipments. This quality at Bridgeport is safeguarded by using the electric furnace exclusively.

Ledrite is manufactured in diameters up to 3 inches, and in round, square, or hexagonal shapes. The physical properties vary somewhat with the size. An average figure for tensile strength is 57,000 pounds per square inch; average elongation in 2 inches is about 25 per cent.

For very severe service conditions, requiring extremely high mechanical strength or corrosion resistance, Duronze* III, an aluminum silicon bronze developed by Bridgeport, may be used for the manufacture of screw machine parts with highly satisfactory results. This alloy possesses

(Continued on following page, column 2)

Duronze wood and metal screws, manufactured by Reading Screw Co. (American Screw Co., licensor), using the new patented Phillips recessed head.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A collet feed-finger is designed to feed bar stock when it is important that surface scratching be eliminated. It is said to be especially suitable for use on metal parts which are to be plated after machining.

A slotting machine is claimed to be suitable for automatic operations on screw heads and similar parts. A band saw cuts a smooth, practically flat-bottomed slot in the screws, which are automatically hopper-fed, clamped, slotted, and ejected at high speed. The machine is easily adjusted for different sizes of screws.

An electric arc saw is said to be suitable for use on any non-ferrous metal, as well as on iron and steel. A low-voltage arc precedes the cutting blade and heats the metal to a plastic condition, in which it is easily and smoothly cut by the saw blade.

Transfer screws simplify the task of accurately locating the centers of threaded holes. The screws, which are made with center points, are placed in a completed piece. The piece in which the location of the holes is to be duplicated is then placed over the screws. A single blow on the new work clearly marks the exact position of the holes.

An automatic threading machine carries out all operations from blank to finished nuts. Blanks are fed from hopper by gravity. Nuts and chips are delivered separately, the chips being washed away by cutting lubricant and collecting in a removable drum box. Nut blanks are delivered through a revolving head and onto the tap. After tapping, the nuts slide down a delivery chute.

A new soldering unit is reported to be suitable for all types of soft soldering work. It is electrically operated, eliminating the necessity of using an open flame. The complete unit consists of a transformer and four soldering heads. Among the suggested applications are the soldering of terminals and lugs and the sweating of copper tubing.

Sisalin sections are recommended for the intermediate operations between polishing and buffing. They consist of sisal—a tough fibre—in mat form, interleaved with layers of muslin. They are suitable for use on brass, copper, and many other metals, and are said to be especially effective in removing minor imperfections from the metal. The composition to be used varies with the metal and the type of finish desired.

A portable plating unit is said to be especially suitable for small work. It can be used for renewing plated surfaces and for similar minor operations.

FREE CUTTING ROD

(Continued from preceding page, column 3)

unusually high resistance to corrosion, both from exposure to the elements and from the action of acids and other corrosive solutions. The tensile strength of Duronze III Rod varies from 85,000 pounds per square inch in the larger diameters to approximately 100,000 pounds per square inch in the smaller sizes.

Booklets describing Ledrite and Duronze may be obtained by writing to the Bridgeport Brass Company.

Silicon Bronze Alloys Form Strong Castings

Fabricators frequently find that certain shapes of parts can be produced most conveniently and economically by the casting method. The alloys of copper, noted for the wide range of fabricating processes which can be applied to them, lend themselves satisfactorily to this method of manufacture, provided due care is taken in the selection of the specific alloy used.

Where strong, non-corrosive, non-magnetic parts are required, certain of the silicon bronze alloys may be used with marked success. Of the silicon bronze alloys manufactured by Bridgeport, Duronze* II and III are particularly well adapted for casting purposes. Sand castings made from Duronze II, when cast under the proper conditions, have a tensile strength of approximately 40,000 pounds per square inch, and are sharp and clean. Such castings are frequently used in the manufacture of electrical equipment for outdoor service, mine machinery, and equipment for underground locations.

When sand cast Duronze III attains a tensile strength of 60,000 to 70,000 pounds per square inch and an elongation in 2" and a reduction in area of approximately 25%. These figures are remarkably high for a non-ferrous alloy. Like the other silicon bronzes, Duronze III has a very high resistance to corrosion.

Makers of castings are invited to confer with Bridgeport on the selection of the most suitable ingots for their specific purposes.

BRASS TERMINOLOGY

This is the fourteenth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys.

In placing orders, it is common practice in the industry today to observe the following procedure:

All gage numbers applying to orders for Brass, Bronze, Copper, Nickel Silver, Phosphor Bronze and Duronze in the form of Sheets, Wire and Rods will be interpreted according to the American or Brown & Sharpe's standard, unless otherwise ordered.

Custom has made Stubs' or Birmingham Gage the standard for pricing Seamless Tubes and unless otherwise specified, gage numbers as applied to the thickness of Seamless Tubes will be interpreted according to that standard.

The adoption of the Micrometer Caliper to determine the thickness of metal or the size of wire in decimal parts of an inch, and the abolition of all gage numbers when ordering, is strongly recommended. This will prevent confusion, expense and lost time.

When ordering Seamless Tubes, state whether the diameter is "inside" or "outside," otherwise it will be considered that outside measurements are required.

Anneals and Tempers

All of the materials before named are produced annealed to various degrees of softness and rolled or drawn to various tempers, to meet special requirements.

The character of either the anneal or the temper should always be specified, but in the absence of any instructions, Sheet Brass will be shipped annealed suitable for drawing. The tempers commonly ordered for Sheet Brass are "half-hard," "hard" and "spring."

Wire and Rods will be shipped "commercially hard" unless otherwise ordered.

Nickel Silver Wire is commonly supplied annealed.

Seamless Tubes will be shipped "semi-annealed," with the following exceptions:

Commercial Bronze, Copper, Phosphor Bronze, Duronze and other special tubes where the requirements are known.

It will be of great assistance in executing orders for tubes, if it is particularly mentioned when stock is required for bending, coiling or flanging.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,** for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers; oil refineries, and process industries.

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WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

BRASS "Bridgeport" CO.

Established 1865

COPPER WATER TUBE AND FITTINGS—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

*Trade-name.

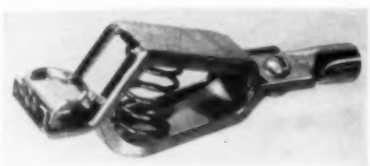
BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

AUGUST "Bridgeport" BRASS CO. 1938

300-AMPERE GROUNDING CLAMP MADE OF GILDING METAL



The Big Brute Clip, rated at 300 amperes, is the newest addition to the line of spring clips made by Mueller Electric Company, Cleveland, Ohio. Constructed throughout of solid copper and gilding metal, the clamp is believed to be the largest ever made.

One of the most important uses of the clip is as a ground clamp in heavy-duty welding, but it has other applications also. Oil companies have found it suitable for draining off static electricity during the unloading of a gasoline tank car or truck. It is also used for making test connections to large motors and generators.

The clip has a spring tension of 65 pounds and a jaw spread of 2 inches. A copper lug is supplied for making cable connection.

DURONZE II SAND-CAST PARTS IN OVERVOLTAGE PROTECTORS

Sand castings made from Duronze* II ingot are used for all metal parts in the cone gap overvoltage protector designed and developed by Pacific Gas and Electric Co. for the safeguarding of telephone lines.

High corrosion resistance of this silicon bronze alloy was an important factor in its selection for this equipment, which is, of course, constantly subjected to weather conditions.

Other advantages are the high tensile strength and dense structure of the cast parts. Sand castings made from Duronze II have a tensile strength of approximately 40,000 lbs. per square inch, and are sharp and clean. They are suitable for parts subjected to the attack of salt water and corrosive liquids. Duronze II is superior to copper in corrosion resistance.

DURONZE III (Pat. No. 1,510,242) SAND CASTINGS COMBINE STRENGTH, CORROSION RESISTANCE

Tensile Strength of Castings About 70,000 Pounds per Square Inch

Manufacturers of parts which can be most economically produced by the sand-casting process find in Duronze* III ingot an alloy suitable for extremely severe service conditions. Duronze III (a patented Bridgeport alloy—Patent No. 1,510,242) is a silicon aluminum bronze of unusually high tensile strength, with marked resistance both to mechanical wear and to corrosive attack.

Tests made on samples of Duronze III sand castings show striking results in strength and elongation values:

	Tensile Strength (Lbs. per Sq. In.)	Per Cent Elongation	Per Cent Reduction In Area
Sample 1...	69,600	21.0	26.5
Sample 2...	70,400	22.0	27.2
Sample 3...	73,100	26.5	25.5
Sample 4...	73,700	28.0	29.2
Average..	71,700	24.4	27.1

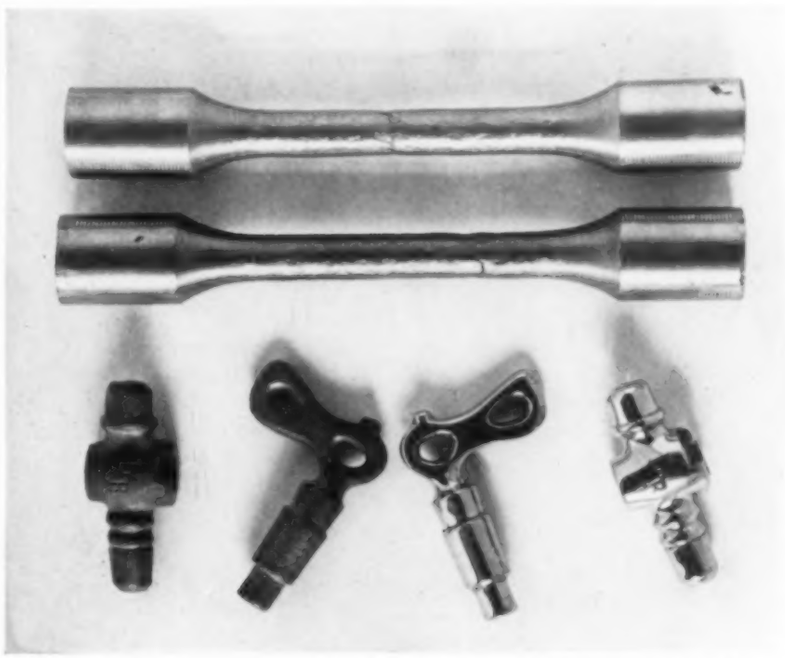
Comparative tests on sand castings of Duronze III, other silicon bronzes, and Monel metal emphasize even more strongly the properties of Duronze III:

	Approxi-Tensile Strength	Per Cent Elongation In 2 Ins.	Specific Gravity
Alloy A†...	45,000	15	8.54
Alloy B†...	53,000	50	8.54
Alloy C†...	40-45,000	12-16	8.58
Monel Metal	65-90,000	5-35	8.80
Duronze II.	40,000	30	8.55
Duronze III	**70,000**	**25**	**7.69**

†Competitive Alloys.

The specific gravity of Duronze III is approximately **10 per cent lower** than that of the other alloys listed, while the tensile strength is considerably higher. The use of Duronze III therefore permits the making of castings of much greater strength with an actual reduction in weight.

(Continued on following page, Column 2)



ABOVE: Samples of Duronze III which have been subjected to ultimate breaking strength tests.

BELOW: Duronze III sand castings as they come from the mold and after polishing and lacquering.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A vacuum lifter for feeding and positioning sheet metal blanks in stamping and forming machines is said to provide safety for the operator. A vacuum cup lifts the sheet metal; a lever-operated valve breaks the vacuum to release.

A flaring tool is reported to both flare and burnish the tube end. The flaring head rides against a ball bearing thrust collar to minimize friction. Tool is regularly supplied with collets for 1/4, 3/8, 1/2, and 5/8-inch tubing; additional collets are available for 3/16 and 3/4-inch sizes.

A new plating material is said to produce an imitation gold plate over brass, copper, and other metals. Color variations can be obtained by varying the plating voltage. A coat of lacquer is used to protect the permanency of the work.

A polishing and buffing machine is of the automatic straight-line conveyor type, and is said to be adapted to a variety of shapes and sizes. Machine can be furnished in different sizes to accommodate any number of wheel-heads. Wheel-heads are of the universal type, with adjustments for setting wheels at any angle from horizontal to vertical.

An electric marking tool is designed to produce permanent markings on brass, bronze, and many other metals. The marking process, according to the manufacturer, is as simple as writing with a pencil. The tool can be furnished ready to plug into any alternating current socket.

A circular saw is said to be especially suitable for cutting non-ferrous metals. The saw is made in segments, each segment having five teeth tipped with tungsten carbide. In case of damage to a tooth, the segment can be easily replaced.

A drilling and tapping machine is designed for production work on small metal parts. It is said to complete both drilling and tapping operations at the rate of 1,200 pieces an hour. The metal part is dropped into one of twelve chucks on a revolving table, drilled, tapped, and ejected by a blast of air. The entire process is automatic.

DURONZE III CASTINGS

(Continued from preceding page, column 3)

Duronze III has exceptionally high resistance to a wide range of corrosive agents, and is particularly suitable for use in contact with acid solutions. It is well adapted to the manufacture of parts which must combine strength and corrosion resistance. Among its applications are valve bodies and stems, gears and pinions, water meter parts, sewage reclaiming equipment, compression fittings for underground service, pole line and marine hardware, and other cases where high strength is required.

The casting procedure followed for aluminum bronze or yellow brass is equally applicable to Duronze III. Care should be taken not to overheat the metal during melting—nor should it be violently stirred. Molds should be amply gated to take care of shrinkage. Bridgeport will gladly discuss with manufacturers the use of this alloy for sand castings. Considerable information on the Duronze alloys is contained in the "Duronze Manual," available on request.

Fabricated by Many Processes

Because of the variety of fabrication processes to which it lends itself, this alloy is suitable for equipment in which it is desirable to use a single metal for several different types of parts. If a particular item cannot be cast economically, Duronze III in rod form can be fabricated by hot forging or on automatic screw machines. Duronze III rod in most sizes is supplied with the remarkably high tensile strength of approximately 100,000 lbs. per sq. inch. Hot forgings average about 90,000 lbs. per sq. inch in tensile strength. These values are considerably higher than those possessed by other so-called high strength bronzes on the market. Duronze III, furthermore, is free-machining and can be cut about 70% as fast as free-cutting brass rod. The manufacturer can select the process best adapted to each part, while retaining uniformity of appearance and composition. This is a special advantage where it is desirable to avoid the presence of dissimilar metals in contact with an electrolyte.

BRASS TERMINOLOGY

This is the fifteenth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys.

Considerable confusion exists in regard to the meaning of such terms as ingot, bar, rod, wire, etc. This confusion arises partly from the fact that in certain respects there are variations between the definitions prevailing in the brass and in the ferrous industries. Moreover, in the brass industry itself, the correct term to use depends not only upon the shape of a piece of metal and the method by which it has been produced, but also upon the *purpose* for which it is to be used. Some of the terms to be defined apply specifically to brass and others to copper.

Ingot, applying to both brass and copper, refers to an open-mold casting which is intended for remelting to form sand or other castings. The mold is usually brick-shaped. This definition is in sharp contrast to steel mill terminology, in which an ingot is a cast bar which will later be rolled.

Brass Terms

The remainder of the terms in this column apply specifically to brass.

Bar designates a piece vertically poured in a metal mold, to be later hot or cold rolled into sheet or strip.

Billet is a piece vertically poured in a metal mold which is usually cylindrical in shape, although rectangular molds are sometimes used. It is later reheated to red heat and extruded or hot rolled to form rod or wire, or hot pierced in a Mannheim machine to form tubing.

Wire bolt refers to a rod about 1¾ inches in diameter and 4 to 5 feet long. Wire bolts are vertically poured in a metal mold and formed into rod or wire by a cold rolling process.

Shell is vertically poured into a metal mold to form a tube with a heavy wall. It is redrawn to form pipe and tubing.

It will be noted that each of these terms refers to a cast piece, which is later to be converted into another form. Next month's column will discuss the meanings of terms applied to different types of copper castings, and also of terms applying to the shapes formed from both brass and copper castings.

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BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

SEPTEMBER — "Bridgeport" Brass Co. — 1938

DOMESTIC POWER OUTPUT RISE PRESAGES APPLIANCE SALES

Expansion in the residential use of power has greatly increased the opportunities for the use of copper and copper-base alloys. A direct result of the rising consumption of electrical energy is the use of large quantities of copper in the construction of generating and distributing equipment and of transmission lines. More important to the fabricator of copper and its alloys, however, is the fact that the growth signifies an increased use of electrical appliances. The trend of residential power use, consistently upward except for temporary setbacks, indicates that the possibilities of this market are far from exhausted.

Refrigerators, clocks, irons, washing machines, water heaters, and oil burners are but a few items from the long list of electrical appliances which have played a part in increasing 1937 residential consumption 77 per cent over the 1929 figures. (During the same period commercial users increased their demand 28 per cent.)

Rural Areas Best Market

Particularly interesting to manufacturers of electrical appliances is the extremely rapid growth in the use of electricity in rural areas in the last two years. In 1935 rural consumers numbered 788,795; last year the total had swelled to 1,241,505. These figures represent an increase of approximately 57 per cent, but in the same period the number of kilowatt-hours consumed rose only 40 per cent. There has, therefore, actually been a decrease in the amount of energy used per consumer—a sharp contrast to conditions in the country at large, where energy consumption has risen much more rapidly than number of users. In view of these figures, it is reasonable to assume that purchases of electrical appliances in rural areas have lagged behind those in other sections of the country, and that a considerable potential market exists in the rural districts for the appliance manufacturers.

Possible expansion of housing facilities and rewiring of existing buildings to replace wiring systems rendered inadequate by increased loads are other activities which are expected to increase the demand for copper and copper-base alloys.

5,000-Year-Old Copper Pan

Among the exhibits in the University of Pennsylvania Museum is a copper frying pan which was excavated at Tepe Gawra in 1930. The age of the pan is estimated to be 5,000 years; yet it has so successfully resisted the inroads of time that it could be used today for the purpose for which it was originally made—a striking illustration of the ability of copper to withstand the test of time.

COPPER TUBING AND SOLDER-TYPE FITTINGS AID RAILWAY, MARINE, INDUSTRIAL FIELDS

Freedom From Vibration Troubles, Corrosion Resistance, Lightness, are Factors in its Increasing Application

Copper tubing with solder-type fittings which has established its superiority over more easily corrosible metals for domestic plumbing installations, is becoming increasingly important in a long list of applications in the industrial and marine fields.

For general-purpose piping in industrial plants its major advantages are its ease of installation, long life, low maintenance cost, and ready adaptability to changes in plant structure. Because of its high resistance to attack by atmospheric moisture, clean water, and solutions that are not exceptionally corrosive, it is ideally suited for keeping air and liquids conveyed by it free from contamination. Typical examples of its use, in addition to water piping, are compressed air lines, air conditioning and refrigerating equipment, and piping in laundries, sugar refineries, breweries, tanneries, dye works, and rayon plants.

Flexible copper tubing can be readily bent to clear obstructions, and can be used in smaller sizes than ferrous pipe, because no allowance is necessary for future restriction of the passage by rust. Maintenance and servicing of copper lines assembled with solder-type fittings may be readily carried out, since by heating the fittings the solder of the joint is softened, and the fitting may be removed and replaced without difficulty.

Marine Service

The resistance of copper tubing to damage from vibration is one of the factors that make it suitable for the construction of pipe lines on shipboard. A contributing advantage is its lightness in weight compared to other types of piping. These same factors have led to its use in other fields of transportation, such as air conditioning equipment, heating, water and air lines in railways, gas lines on automobiles, and oil lines for hydraulic brakes.

Approved for Fire-Protection Sprinkler Systems

Approval of Bridgeport's copper pipe for use with solder-type fittings for fire-protection sprinkler systems by the Underwriters' Laboratories, Inc., of the National Board of Fire Underwriters, opens up a new field. Formerly the regulations for the installation of sprinkler equipment required that "all piping shall be installed by means of screwed or flanged fittings," and in the

(Continued on following page, Column 2)

Courtesy American Radiator Co.

Copper tube and solder-type fittings are utilized for all types of supply lines on many of the new streamlined trains. This photo shows the piping connections on the air supply reservoirs of the air brake equipment. Copper is preferred because of its resistance to corrosion and rust, its light weight and dependability, and the fact that vibration cannot loosen the fittings, as there are no screwed joints.

Copper and Silver Combined In New Container

An interesting application of copper is in the construction of new containers designed for essential oils and similar materials. The containers are made of a sheet formed by combining a sheet of copper with a sheet of silver, which is approximately one-tenth the thickness of the copper. The silver is inert to the liquids for which the container is used; the combination with copper permits the manufacture of a container of adequate strength at moderate cost.

New Metal Coating Process

A new process for coating brass, copper, and other metals with tin is said to be applicable to the most complicated fabricated shapes. The method consists in suspending the articles for a few minutes in an atmosphere of hydrogen and stannous chloride vapor at a temperature of 500 to 600 degrees C. The hydrogen reduces the stannous chloride to tin which then alloys with the article. Thickness and composition of the alloy formed depend upon regulation of temperature and exposure time.

PREPARED EACH MONTH BY THE BRIDGEPORT BRASS COMPANY

Headquarters for Brass, Bronze and Copper

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column *lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.*

A wire reel, originally developed for use with metal spray guns, is said to be suitable for any application in which it is important that wire be fed without kinking or drag overloading. The complete unit consists of the reel with ball-bearing mounting and a metal stand with tray and tool drawer. The reel operates with adjustable brake which prevents overrunning and can be set to maintain the desired tension on the wire.

A polishing attachment can be applied to a polishing-wheel stand in order to manipulate the work against the wheel. The work is placed on the machine spindle, which is motor-driven under control of the operator, who can start and stop rotation and bring the work against the polishing wheel or move it away as he desires.

A new metal polish is said to produce a deep, shimmering lustre without haze, and to leave no heavy residue to cling to rough surfaces and cracks.

An air cleaner for grinding and welding operations is said to remove approximately 95 per cent of the dirt from the air in the vicinity. It consists of a motor-driven fan which produces suction to draw air through a flexible metal tube and exhaust it in a filter located in the periphery of the power unit.

A new buff is designed for faster cutting, longer buff life, and better finish. The cloth used in the buff is folded in such a way as to present a larger number of edges to the work which will produce a cutting rather than a rubbing action. Air spaces between the folds of the cloth dissipate the heat produced by friction.

Wrinkle finishes are now available in practically all colors. In the past these finishes have been limited to the darker colors, but pastels and even white can now be used without discoloration in the baking process. The new finishes are also said to bake hard and wear-resistant with a short baking schedule.

Barrel plating equipment of the hopper type is reported to give low production costs and high capacity, proper control of treatments, and in general a more effective job than is possible with dipping baskets.

COPPER TUBING USES EXPAND

(Continued from preceding page, column 3)

case of concealed pipe systems that "pipe shall be of standard weight wrought iron or steel, painted with two coats of good protective paint, one before and one after installation."

However, after due investigation, Bridgeport's copper pipe was found "suitable for use in lieu of wrought iron or steel in the fabrication of automatic sprinkler branch lines when used with listed solder-joint type fittings" and the following recommendation was accepted and approved:

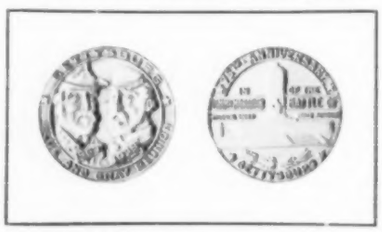
"Bridgeport" hard drawn, copper water tube, for use with listed fittings (solder-joint type) in fabrication of branch lines, trim, of alarm and dry pipe valves, supply and heater connections to gravity tanks, bell line piping and other similar piping of automatic sprinkler equipment, where working pressures do not exceed 175 lbs. per sq. in., in the following types and sizes:

Type K— $\frac{1}{4}$ to 2 in., inclusive.
Type L— $\frac{3}{4}$ to 2 in., inclusive.
Type M—$1\frac{1}{4}$ to 2 in., inclusive.

Much valuable information on the properties and applications of copper tubing is contained in the booklet, "Water Pipe Sizes," copies of which may be obtained by writing the Bridgeport Brass Company.

Copper Alloys Popular for Commemorative Medals

The copper alloys, long in life because they resist the effect of time and weather, are peculiarly suitable to the striking of commemorative coins or medals because of the inherent attractiveness and popularity of the rich bronze and warm golden colors obtainable. Where other metals quickly tarnish or corrode, the copper alloys retain their attractive appearance for long periods.



Typical of this application are the medals of high copper brass manufactured by The Metal Arts Co., Inc., of Rochester, N. Y., to commemorate the 75th Anniversary of the Battle of Gettysburg.

BRASS TERMINOLOGY

The terms discussed in this column in the August issue of the COPPER ALLOY BULLETIN, with the exception of ingot, apply specifically to brass.

Brass and Copper Terms

There is another group of terms, which may apply to both brass and copper, and which require clear understanding. The terms in this group may be conveniently arranged in three pairs: sheet and strip; rod and wire; pipe and tube. These terms give rise to considerable confusion, because both of the terms in any one pair refer to forms of metal which display marked superficial resemblances to each other.

Sheet and strip are practically synonymous. The wider form is referred to as sheet and the narrower form as strip. Both may be furnished flat or in rolls.

Rod and wire are sometimes incorrectly believed to be differentiated by their dimensions. Actually no such distinction exists. Rod is furnished in straight lengths; wire in the form of coils. For example, a coil of metal 1 inch in diameter is wire, while a straight length $\frac{1}{2}$-inch in diameter is rod. In other words, straightened wire cut to length becomes rod.

Pipe and tube have already been discussed in an earlier issue. If dimensions are based upon Standard Pipe Sizes (also referred to as Iron Pipe Sizes), the form is a pipe. In the case of copper water tubing, the nominal size is always $\frac{1}{8}$-inch smaller than the actual outside diameter. In other words, a 2-inch copper tube has an actual O.D. of $2\frac{1}{8}$ inches. Seamless tubing applies to brass or copper tube which is outside the dimensions of pipe and water tube and which is used for other purposes.

Copper Terminology Only

The following terms apply to copper:

Ingot bar is a multiple ingot, equivalent in weight to about three ingots.

Wire bar is flat poured into a metal mold in the shape of a rectangular rod tapered at each end. It may also be end poured in which case the gate end is pointed. Size is approximately 4 inches by 4 inches by 4 to 5 feet long, depending on weight.

Cake is cast in a square open metal mold or end poured, and later hot rolled into sheet or strip.

Slab is cast in a rectangular open mold for rolling into strip.

Wedge Cake, end poured, is a rectangular bar about 4 by 12 by 12 inches for hot rolling into sheet or strip.

Cake, end poured, is a rectangular bar end poured in metal mold for hot rolling into sheet or strip.

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BRIDGEPORT BRASS

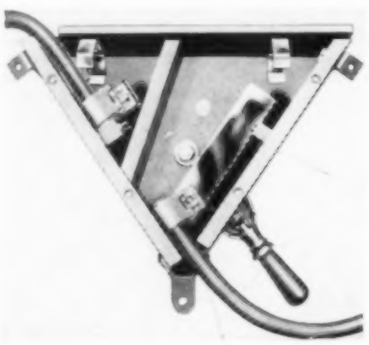
COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

OCTOBER — "Bridgeport" BRASS CO. — 1939

NEW FEEDER SWITCHES USE COPPER AND BRONZE PARTS

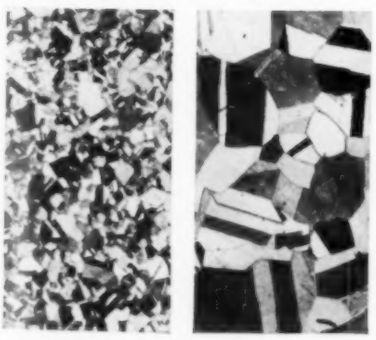
New safety feeder switches, designed and built by Ohio Brass Co., Mansfield, Ohio, are furnished in ratings of 300 and 400 amperes, and are expected to fill the need for adequate switch installations of moderate capacities. Following the same general designs as the manufacturer's 600- and 1,500-ampere switches, the new devices are of the quick-make, quick-break type enclosed in a fireproof case. An im-



portant use of the new switches is in sectionalizing mine circuits or heavy-duty shop circuits. In this type of service the switches provide a safe means for disconnecting under load without damage.

The working parts, knife blade, and contacts of the switch are of pure copper stock. Terminals are cast bronze.

Microstructures of Brass



LEFT: Fine grain structure helps to keep surface of finished article smooth. RIGHT: Coarse grain structure increases polishing costs. (Mag. 75X). See chart at right for annealing characteristics of yellow brass sheet.

PROPER ANNEALING FACILITIES IMPORTANT TO THE MANUFACTURER OF BRASS GOODS

Correct Procedure Will Increase Quality and Reduce Costs

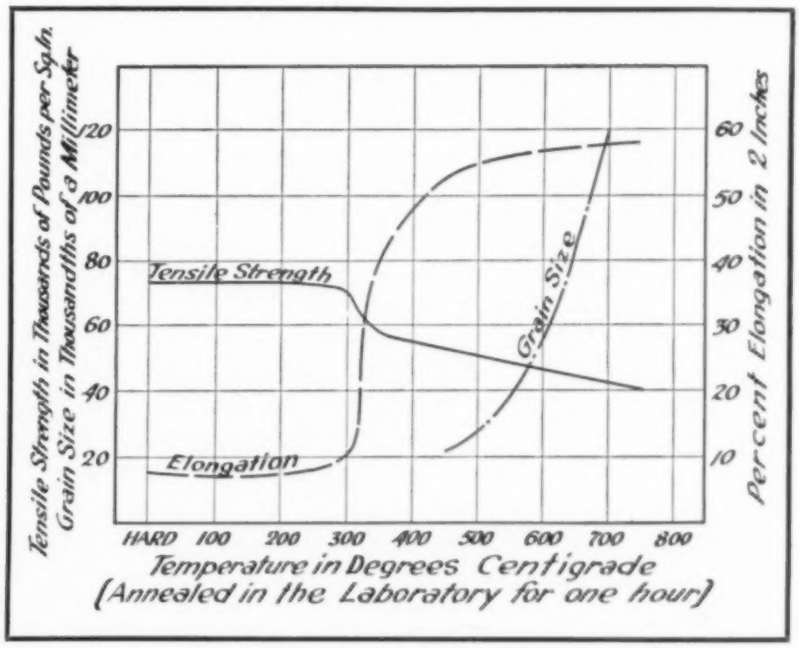
The manufacture of items from brass or other non-ferrous alloys often involves cold working the metal to such a degree that one or more annealing or softening operations must be carried out in the fabricator's own plant. If satisfactory results are to be obtained, these annealing operations must be performed with as much care as any of the other steps in the fabricating process. Adequate annealing furnaces and equipment for cleaning the metal in acid solution and thoroughly washing it are required. The fabricator also needs a good working knowledge of the annealing process.

Prior to the first step in the cold working process, the metal used by the fabricator possesses the characteristics resulting from processing at the supplier's mill. Here annealing is carried out under the strict supervision of the metallurgical laboratory, and the finished metal is supplied within close limits as to structure and physical properties, in order that the fabricator may use it with the greatest economy. Before shipment, samples of the metal are taken and laboratory tested to insure the correctness of all properties.

Need of Intermediate Anneal

As soon as the metal has been subjected to cold working, that is, forming, stamping, cupping or drawing, it hardens. If a considerable degree of cold working is involved, the metal becomes too hard to work satisfactorily, and under these circumstances the additional annealing in the fabricator's plant is necessary in order to complete the manufacturing process. Unless this anneal is properly performed, excessive product cost or poor quality may result.

(Continued on following page, Column 2)



These curves show the annealing characteristics of yellow brass sheet which were attained by testing samples of brass annealed in the laboratory for one hour. In actual practice, the temperature of the furnace may be about 50° C. higher than the temperature attained by the method.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

An automatic buffer, according to the manufacturer, applies equal pressure on all critical surfaces. The machine requires 15 minutes or less to set up, and can be used for brass, steel, or plastics.

A new lacquer is reported to be especially suitable for protecting metal surfaces exposed to salt spray, such as small boat parts. It can be applied by brush over chromium, brass, bronze, or copper, and dries in 15 minutes. It is transparent, tough, elastic, and resistant to sunlight.

A calculating rule for determining the weight of flat steel lists conversion constants for copper, bronze, and other metals. Rule includes scales of thickness from .001 to 6 inches, width from $\frac{1}{4}$ to 96 inches, and length from $\frac{1}{8}$ inch to 1 foot in inches and parts of an inch and from 1 to 1,000 feet in feet and parts of a foot.

Cutting lubricants for non-ferrous metals are said to be non-corrosive and non-tarnishing. They consist of sulphurized oils in which the sulphur is permanently incorporated in the body of the oil and will not separate out. Lubricants will not gum or form deposits on machine-tool parts.

Anode bags of glass cloth are reported to aid in obtaining the smoothness of nickel plate required when a chromium finish is to be applied. Bags are of one-piece tubular construction, sealed at one end by a special process, and can be used for all acid solutions and for many alkaline solutions.

Threading and tapping operations can be performed simultaneously with a new tool, even when the thread pitches are different. The tool, which can be used on chucking machines, turret lathes, and automatic machines, eliminates rechucking the work. Essentially, the tool consists of an adjustable die-head combined with a compensating tap-holder. Correct pressure for starting the external threading operation is supplied by the tool-holder, after which the die-head floats on its own lead, independently of the tap.

Melting furnaces for brass and bronze are made in three sizes for tilting and two sizes for stationary design. Units are gas-fired; burners are arranged for equal heat distribution.

A pipe vise stand is equipped with power unit and check to permit threading, cutting, and reaming of all sizes of pipe up to 2 inches. Pipe is gripped in a bar-operated scroll-type chuck and revolved by the power unit. Chuck speed can be varied from 14 to 32 RPM. Motor is operated from 110-volt supply.

PROPER ANNEALING

(Continued from preceding page, column 3)

This intermediate anneal is as important to the fabricator as the original mill anneal. If the fabricator's annealing furnace has inadequate capacity for his requirements, he is forced to increase the temperature at which he operates his equipment, and must reduce the annealing time to a short period. Under these conditions a uniform anneal is almost impossible. While parts of the charge may be correctly annealed, others may be insufficiently softened, and difficulty will be experienced on subsequent cold working operations. Other parts of the charge may even be over-annealed, giving rise to too large a grain structure. The finished article will then have a rough surface and may even develop small checks.

Over-Anneal Raises Costs

Bright dipping will often reveal over-annealing, as the metal takes on a matte lustre. Forming or stamping metal that has a coarse grain structure stretches it locally and causes the surface to become rough. An excessive amount of buffing and polishing is then required. Not only do finishing costs rise, but poor quality results. When such material is plated, an inferior plate is deposited because the grain structure of the metal influences the structure of the plate deposited on it.

Securing the Correct Anneal

The annealing process should therefore be carefully controlled to produce a temper which best meets the requirements of both cold working and finishing. If possible the grain structure should be kept as fine as possible without leaving the metal too hard for the necessary cold working operations which follow. The proper grain structure will do much to keep the finishing costs down and will at the same time improve the quality.

Fabricators who have annealing problems can avail themselves of the experience of Bridgeport's laboratories. Suggestions and advice will enable the fabricator to produce his articles with the greatest ease and lowest cost consistent with product quality. Bridgeport's wealth of research and experience can often save much time and expense for users of brass mill products.

BRASS TERMINOLOGY

This is the seventeenth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys.

In the case of sheet and strip there are several terms descriptive of operations performed on the metal after the rolling process. In some cases these operations are part of the normal manufacturing process; in other instances they are intended to produce metal with special characteristics.

Slitting applies to the process of cutting wider metal into narrower strips by passing it through rotating circular shears, which cut it to the finished width. This process is customary in the production of widths too narrow to be economically rolled.

Shearing indicates the process of trimming the edges of metal on a straight shear, and is usually applied to sheet rather than strip. The term is also used to differentiate metal cut with a shear from that trimmed with a saw.

Sawing designates trimming the edges by a saw. The process is used for flat sheets or bars, generally too thick to be sheared without breaking or distorting the edge.

Special Operations

The terms **flattening, patent leveling,** and **resquaring** apply to processes used when fabricating requirements demand absolutely flat surfaces or square edges. The additional manufacturing expense involved increases the price of the metal and these processes should therefore not be specified unless necessary.

Flattening is a process by which the metal is passed through special straightening rolls which flatten it without effecting any change in the gage.

Patent leveling is really a special type of flattening. In this process the metal is straightened and flattened by stretching it in a machine which is specially designed for the purpose. This term is usually applied to sheet.

Resquaring, as the name indicates, denotes a process for squaring the edges of the metal with respect to each other after the rolling operation. This term also applies to sheet. In the resquaring process the metal is cut on a straight shear so that each of the corners of the sheet forms an angle of 90 degrees.

Camber, applying to sheet, rolls, and narrow strip, designates the departure from edge straightness.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,** for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers; oil refineries, and process industries

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS CO. *Established 1865*

COPPER WATER TUBE AND FITTINGS—For plumbing, heating, underground piping.

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FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

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BRIDGEPORT BRASS

Advertisement

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

NOVEMBER — "Bridgeport" Brass Co. — 1938

EYE APPEAL IS ENHANCED BY BRASS ESCUTCHEONS

Manufacturers of automobiles, refrigerators, stoves, and radios are making extensive use of brass and bronze escutcheons and name plates to increase the merchandising appeal of their products. The natural attractiveness of the copper alloys and the ease with which they can be polished, plated, or enameled are factors that aid in enhancing the appeal of the merchandise to the eyes of prospective purchasers.

Fox Company, 3400 Beekman Street, Cincinnati, Ohio, manufactures large quantities of these decorative name plates from both brass and bronze and finishes them in gleaming chromium plate or in colorful enamels. Typical of the company's products is the Frigidaire name plate shown in the illustration, which is made of brass and inlaid with enamels.

Corrosion Studies Reported

A recently issued report of Committee B-3 of the American Society for Testing Materials summarizes in tabular form the result of studies on atmospheric corrosion of 24 non-ferrous metals and alloys after six years' exposure in 9 test locations. Results of the change-in-weight tests are not yet conclusive, as many of the test samples still show gains in weight.

A number of interesting comparisons were developed by the studies of changes in tensile strength. In industrial and sea-coast locations zinc, tin, aluminum and aluminum alloys, 70-30 brass, and manganese bronze showed substantial losses in tensile strength. The last two alloys named were the only ones among the various copper alloys tested to show this effect. Copper and the other copper alloys displayed only negligible losses in tensile strength, and similar results were obtained in the case of nickel and high nickel-copper alloys. In rural locations no appreciable loss in tensile strength was noted except in the case of tin.

The data indicate that industrial corrosive conditions are most severe in New York City, and that sea-coast corrosion is most marked at La Jolla, Calif.

QUALITY IS OF FIRST IMPORTANCE IN BRASS SCREW AND RIVET WIRE

Cold heading is probably the most severe operation that metal must undergo in the fabrication of bolts, screws, rivets, and headed products. A coil of wire is fed into a heading machine that straightens it, cuts it off to the precise length, and holds it tightly while it is struck one or more powerful blows, causing one end to swell and fill the inside of the die. Most materials shatter under such impact, but the stiff, hard brass seems to flow like putty to fill the die.

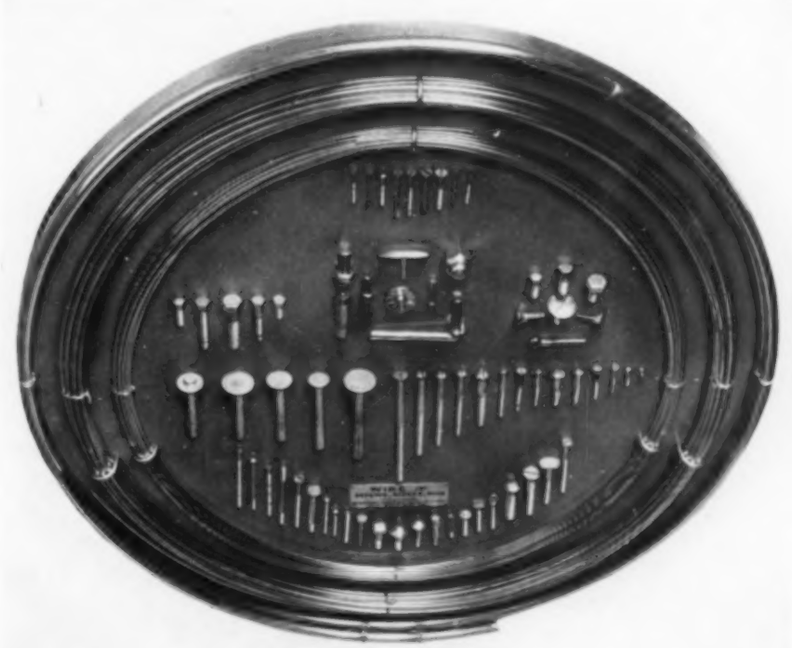
From the mill processing angle the making of brass screw or rivet wire is a fussy job. The alloy must be ductile enough to stand heading without developing internal shearing strains. If the wire is too soft, the shank of the screw or rivet lacks stiffness. A soft wire also may flatten during straightening, and may not shear cleanly and squarely, thus producing lopsided heads.

Since most of the stretching takes place across the grain, the surface will naturally open up, and every scratch or blemish will be enlarged. Moreover, if the grain structure is too coarse, the head becomes rough and pitted and may even crack. The microstructure of the wire is, therefore, of extreme importance, especially when large heads or intricate shapes must be produced.

Each heading job, therefore, requires the right alloy, correct stiffness, proper grain structure, freedom from minute imperfections and uniformity—conditions attained only by close cooperation between laboratory and mill.

From the fabricator's standpoint, the heading process is probably the most economical way of making strong, precise, intricate articles at high speed with little waste. The need of costly equipment limits the method to quantity production.

Manufacturers of screws and rivets will find marked advantages in the use of Bridgeport wire, particularly for large heads, difficult shapes, or items that must meet special engineering requirements. Bridgeport wire will bring profit to many jobs that are now considered "headaches."



PREPARED EACH MONTH BY THE BRIDGEPORT BRASS COMPANY

Headquarters for Brass, Bronze and Copper

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A soldering flux for brass, bronze, and copper, is said to be primarily intended to meet the needs of fast soldering on a mass-production basis.

Cable connectors for a wide range of cable sizes use flattened U-bolts for clamping. They are available in many forms, including angle lugs, T-connectors, elbows, and stud clamps.

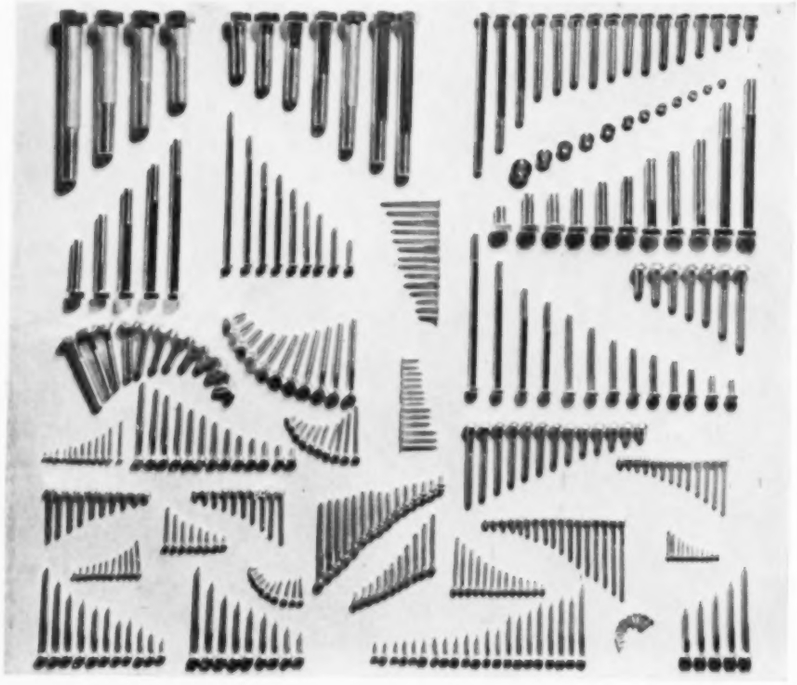
An analytical set for use by electroplaters contains the necessary equipment for determining the pH of solutions. Set includes nine color standards, graduated test tubes and pipette, indicator solution, and brush.

A band saw is reported to be especially suitable for metal working shops using many different kinds of metal. Its speed is variable from 150 to 450 feet per minute.

Portable grinders are available in two sizes with wheel capacities of 2 and 2½ ins. They are precision tools with a no-load speed of 19,000 RPM. Weights for the two sizes are said to be only 3½ and 4½ pounds. Units are balanced for easy handling.

Universal valve disks are built up of alternate layers of asbestos and metal completely encased in a two-piece shell of copper or other metals. They are for use in globe valves, and are said to be suitable for handling air, gas, steam, acids, alkalis, and solvents.

LARGE STOCKS OF DURONZE SCREWS CARRIED BY ROCKFORD



Good News! Duronze Cap Screws ranging from 6" x ¾" to ½" x ¼" with nuts to fit, and Round and Flat Head Machine and Wood Screws in many lengths and sizes are now carried in stock by Rockford Screw Products Co., Rockford, Ill. This takes care of orders for trial and experimental quantities without the penalties of delay or "made to order" prices. On the smaller sizes, Duronze screws have a tensile strength averaging over 100,000 lbs. per square inch. They resist corrosion and season cracking better than screws made of common alloys.

BRASS TERMINOLOGY

This is the eighteenth of a series on the nomenclature peculiar to the industry specializing in the making of brass, bronze and copper alloys.

The type of finish specified on copper and copper alloys has an important bearing both on the cost of the material and on the attractiveness of its appearance. The selection of one or another of the various finishes depends on the relative importance of these two factors. In the following discussion the finishes are arranged in order of increasing cost, the least expensive being named first.

Machine finish leaves the metal in the state in which it comes from the last machining operation, without any cleaning or dipping.

Clean finish is obtained by washing to remove dirt and grease; stains are not removed.

Bichromate dip removes stains and brightens the metal.

Bright dip, obtained by an acid bath, gives a much brighter finish than bichromate dip. It removes stains and scale, and is frequently specified when soldering operations are necessary. It is not recommended if close tolerances are needed.

More Expensive Finishes

Polish is the most expensive type of finish applied to the original metal. It involves preliminary grinding with emery powder, buffing with tripoli, and coloring with rouge or similar material. Polished metals are usually lacquered to prevent marring the surface.

Plating involves the application of a coating of another metal to the base metal. As in the case of the base metal, different grades of plated finish exist. **Dull nickel plate** and **dull chrome plate** are obtained by acid dipping and then plating. These finishes are sometimes designated as **dip nickel** and **dip chrome.**

Buffed nickel and **buffed chrome** are brighter finishes obtained by buffing the metal prior to the plating operation. This type of finish is always used when the plate is subsequently to be buffed and polished. In this case the final finish is known as **polished nickel** or **polished chrome.**

Satin or Butler finish is obtained by dulling the highly polished plated surface by scratch brushing. This type of finish is used when a soft sheen is more desirable than a high degree of gloss.

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BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

Reporting News and Technical Developments of Copper and Copper-Base Alloys

DECEMBER — "Bridgeport" Brass Co. — 1938

DURONZE SELECTED FOR USE IN GROVER CASH CARRIERS

The Grover Company, makers of cash carriers, found in the high strength of Duronze* II the solution for an unusual manufacturing problem. A longer opening was needed in the shell to accommodate sales checks and alteration tags, but the overall length of the carrier could not be increased because of operating requirements of carrier systems which involve short turning radii and right-angle bends at many points along the conveyors.

When the longer opening was cut in the standard brass shell, it was weakened so much that it easily became distorted. By substituting Duronze II for brass, it was possible to increase the length of the opening and retain ample strength, for Duronze II, in addition to the ductility of copper and the endurance of fine bronze, possesses the strength of steel. Duronze II does not become brittle when hard worked, and is resistant to season cracking. By making the shells a trifle longer than standard and folding back the extra length, The Grover Company produced shells of much greater strength than previous designs, while the carriers remained fully interchangeable with other types.

Properties of Deoxidized Copper

Recent investigations indicate that deoxidized copper may have definite advantages over tough-pitch copper when cast in shapes intended for the rolling mill. According to reports of the American Institute of Mining and Metallurgical Engineers, comparisons were made between a sample of the ordinary type of wire bar cast horizontally in an open mold and a sample of deoxidized copper cast in a vertical mold. Plastic characteristics of the deoxidized copper were apparently superior.

PERIODIC CHECK OF METAL SPECIFICATIONS PREVENTS PURCHASING OBSOLESCENCE

In an era in which the problem of obsolescence is receiving increased attention, far-sighted manufacturers are aware that obsolescence may enter into the purchase of raw materials under outmoded specifications as well as into the production process. For this reason many fabricators have recognized the advisability of instituting a periodic check of these specifications.

Two chief factors contribute to the possibility of obsolescence in metal purchases—changes in production methods, and the introduction of new alloys. In the production process, rapid improvements in equipment and methods of fabrication may radically change the requirements for the metal used, even though the finished product remains superficially the same. Moreover, even though no major changes take place in production, the steady development of new alloys has resulted in a considerable expansion of the metals available.

Knowledge of Metals Involved

A check-up of metal purchasing specifications, in order to insure both maximum quality and economy, should therefore be made with a full consideration of all the factors involved. Most important among these factors are the types of fabricating process used and the type of service to which the product will be subjected. The successful execution of such a survey requires not only a knowledge of the demands made upon metals by fabricating and service requirements, but also a comprehensive understanding of the characteristics of the metals themselves.

Many manufacturers find it advisable to supplement their own intimate knowledge

(Continued on Following Page)

Non-Fuming Welding Rod Produces Strong Welds†

Bridgeport's Welding Rod No. 192 has special advantages in the welding process because of its non-fuming properties. The rod is manufactured of manganese bronze to which a small amount of silicon has been added. The silicon content produces the non-fuming quality. In addition, it has a fluxing action which results in the formation of sounder metal and hence of stronger welds than can be obtained with ordinary types of welding rods.

The rod flows smoothly during the welding process, and produces a clean, bright weld, free from the black manganese dioxide film that is sometimes formed by rods high in manganese content.

†*Mfd. under U. S. Pats. Nos. 17,631 and 1,525,058.*

The extensive testing facilities of the Bridgeport laboratories are available to assist manufacturers in modernizing their metal specifications.

COPPER ALLOY BULLETIN

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. Further information on any of these items may be obtained by writing the Bridgeport Brass Company, who will gladly refer readers to the manufacturer or other source.

A new welding cable provides a water-cooled connection between secondary taps of transformer and portable welding gun. It consists of a central rubber core around which are helically wound flexible, tinned copper cables. Leads of opposite polarity are separated by a corrugated live rubber spacer. The construction permits circulation of the cooling water through the core. Outer cover is a flexible rubber tube, reinforced with wire and woven fabric.

Exhaust equipment for grinding and polishing machines consists of a pair of hoods, pipe connections, and motor-driven blower. A filter can be connected to the delivery side of the blower to collect the dust, permitting only clean air to escape.

A metal-working lathe provides spindle speeds ranging from 40 to 1,200 RPM., cuts screw threads from 4 to 112 per inch, and has power longitudinal turning feeds of 0.002 to 0.015 inch. It is said to be especially suitable for machining very small diameter parts of brass and other metals.

A brazing torch is suitable for light brazing, soldering, and for heating copper pipe fittings in sizes to ¾ inch. It produces a brush-type blast flame ranging from 3 inches in length and ⅛-inch diameter to 8 inches by ¼-inch. Temperatures up to 2,500 degrees F. can be obtained. The torch operates on compressed gas supplied in small cylinders by the manufacturer of the torch.

A sanding machine is said to impart a gyratory motion which approximates hand sanding, and is suitable for finishing lacquer or other coats on metal surfaces. Unit consists of a ¾-horsepower motor mounted on caster-equipped stand, with a flexible shaft for transmitting power to the tool head.

A new scleroscope is pocket-size and weighs only one pound. Hardness is measured by a diamond-pointed hammer which rebounds after striking the work; height of the rebound is indicated by a dial which records the hardness of the metal.

A combination instrument includes a metallurgical microscope and camera assembled into one permanently aligned unit. The camera is equipped with a device that changes the magnification of eye-piece by turning a dial. Stage of the microscope is of the inverted type and accommodates polished or fractured specimens of apt shape. Exact standard magnifications for grain size estimations are readily obtained.

A spot welder is designed to handle medium-duty welding of sheet metal. Pressure and current are applied by a foot-treadle. Welding current is controlled by means of a heavy-duty switch.

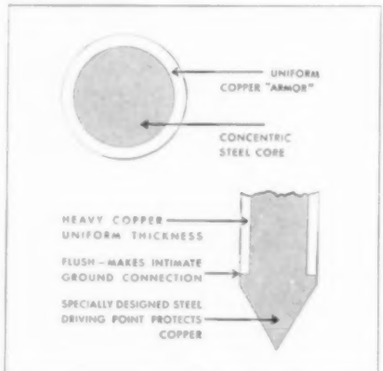
METAL SPECIFICATIONS

(Continued from Preceding Page)

of their production processes and service requirements by the knowledge of metals possessed by a skilled metallurgist. Metallurgical assistance in the making of surveys of metal specifications is an important part of the service to customers which is made available by Bridgeport's extensive laboratory facilities and skilled engineering staff. In addition to original research work in the properties of existing metals and the development of new alloys, the laboratories at Bridgeport are equipped to serve as an important adjunct to the fabricator's own facilities, by studying the suitability of metals of various compositions and tempers to specific requirements.

Copper Ground Rods Resist Rust

Bridgeport Copper Ground Rods, made with a thick, uniform "armor", of copper around a strong steel core, are extensively used in applications requiring grounding for protection, particularly in soil that is moist or has been treated to reduce ground resistance. The copper "armor" gives long life in places in which unprotected rods rust quickly.


UNIFORM COPPER "ARMOR"
CONCENTRIC STEEL CORE
HEAVY COPPER UNIFORM THICKNESS
FLUSH—MAKES INTIMATE GROUND CONNECTION
SPECIALLY DESIGNED STEEL DRIVING POINT PROTECTS COPPER

Bridgeport Copper Ground Rods have a point specially designed for easy driving. The construction of the point protects the copper against damage when the rod is driven into the ground, and gives highly efficient electrical contact.

Line Material Co. is national distributor for Bridgeport Copper Ground Rod.

ALLOYS OF COPPER

Many readers of the COPPER ALLOY BULLETIN have requested the publication of detailed technical information on the various copper alloys. In response to these requests, we are initiating with this issue a series of articles on the composition, physical properties, fabricating processes, and product applications of the more important copper alloys. Each of the alloys will be treated in one or more articles.

COMMERCIAL BRONZE

Commercial Bronze is an alloy consisting of 90% copper and 10% zinc. From the metallurgical standpoint, the use of the term "Bronze" is questionable, because this term properly applies to an alloy containing tin, but the industry has used the name "Commercial Bronze" for so long a time that it has become well established. There are numerous modifications of this alloy, which, while they are not truly Commercial Bronzes, are so similar that they are included in the same class.

The following physical characteristics apply only to the 90-10 alloy. Any modification in the composition will of course produce changes in the physical properties also:

Analysis . . . . . 90% copper, 10% zinc
A.S.T.M. Specifications . B36-38T, Sheet
Modulus of Elasticity,
15,000,000 lbs. per sq. in.
Density . . . . . .318 lb. per cu. in.
Coefficient of Linear Expansion,
0.0000175 per deg. C. (25-100 C.)
Electrical Conductivity,
43% (Copper 100%)
Thermal Conductivity,
47% (Copper 100%)

General Characteristics

Commercial Bronze is somewhat stronger than copper and has equal or better ductility. The structure of the alloy consists of uniform copper and zinc atoms in solid solution. This type of structure produces a ductile metal that is suitable for cold working and forming operations, but not for machining.

The subject of Commercial Bronze and its modifications will be concluded in next month's issue.

The services of the Chemical and Metallurgical staff of the Bridgeport Brass Company are available to customers for the solution of problems pertaining to their metal requirements.

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BRIDGEPORT BRASS

A REVOLUTIONARY STEEL BAR DEVELOPMENT BY LA SALLE

STRESSPROOF *No. 2*

High Strength—Minimum yield point: 100,000 lbs. per sq. in. Has been successfully substituted for heat treated alloy and carbon bars in many applications.

Free Machinability—Machines approximately 80% of Bessemer Screw Steel. Users report cutting speeds in excess of 165 surface feet per minute.

Unique Wearability — Users replacing steels "treated" to approximately 300 Brinell and in some special applications, even case hardened steels, with STRESSPROOF No. 2, machined and used as received, report complete satisfaction with its wear performance.

No Warpage—Complete freedom from warpage after keyseating, splining, threading, step-down and similar machining operations makes this steel ideal for machine tool parts and high strength shafting requirements.

Low Cost—Priced lower than any other high strength cold finished bar steel.

No Heat Treatment Required — Parts machined from STRESSPROOF No. 2 bars are ready for service after last machining operation. Subsequent heat treating is unnecessary and will destroy the combination of high strength, free machinability, non-warpage, and wearability found in the steel.

STRESSPROOF No. 2 Is Produced By La Salle's Exclusive STRESSPROOFING Process
T. M. Reg. U. S. Pat. Off.

The unusual combination of properties inherent in STRESSPROOF No. 2 Cold Finished Steel Bars are obtained only through the La Salle STRESSPROOFING process. Other STRESSPROOF steels can be and have been produced by La Salle by this process but STRESSPROOF No. 2 has been found to be the most applicable in the great majority of cases. Return the coupon or write for descriptive booklet. La Salle Steel Company, Box 6800-A, Dept. 12B, Chicago.

● *The lead screw and helical stoker shaft shown above are two examples of parts now being made from STRESSPROOF No. 2. Other parts are garage tools, pins, flywheel bolts, spline torsion shafts, wringer gears, stoker worms, and many others.*

La Salle STEEL COMPANY

Producers of the Most Complete Line of Cold Finished Steel Bars in America.

WRITE FOR FREE BOOK

LA SALLE STEEL COMPANY
Box 6800-A Dept. 12B Chicago, Ill.

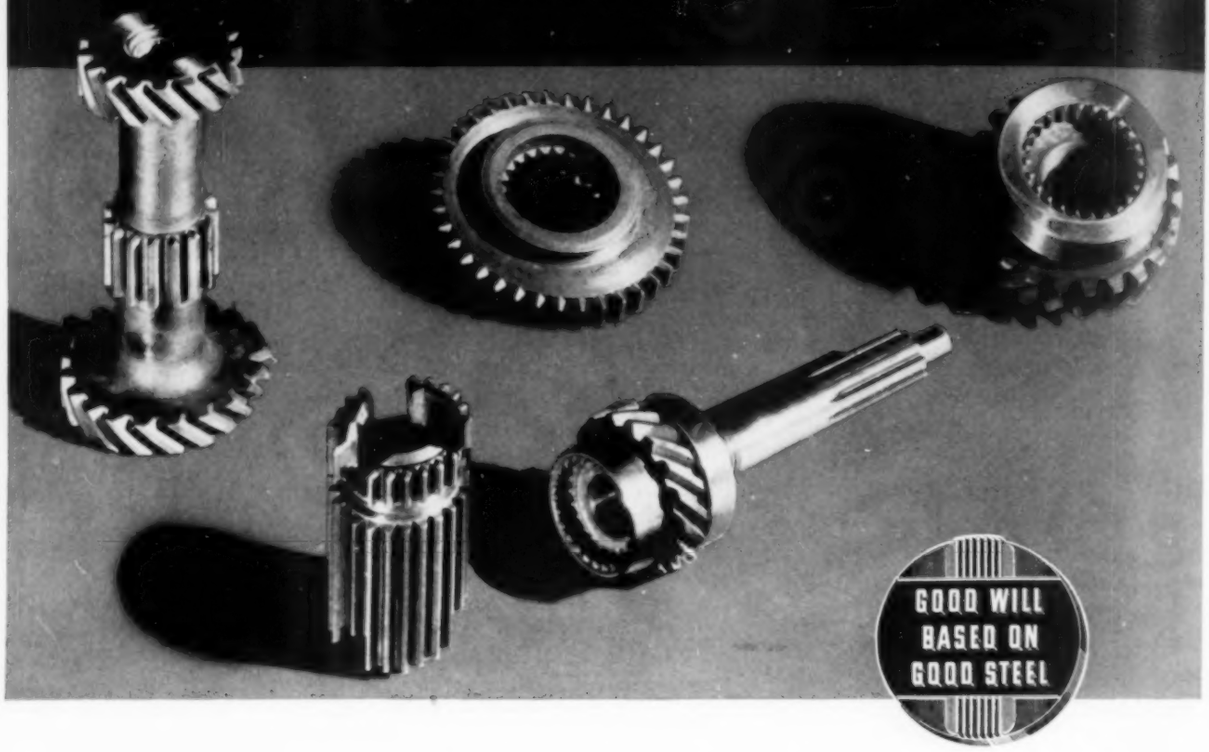
Please send me booklet describing your new steel STRESSPROOF No. 2.

Name_____ Title_____

Firm_____ Address_____

Also send to_____

TIMKEN Oil-Hardening Alloy Steels



The superior physical, metallurgical and metallographic properties of TIMKEN Oil-Hardening Alloy Steels enable better parts to be produced at lower finished cost wherever the use of an oil-hardening steel is indicated—as for example in automobile transmission gears.

TIMKEN Oil-Hardening Alloy Steels respond to heat treatment satisfactorily and uniformly. Furthermore, they show such uniform distortion that shop practices can be placed on a more stable basis, for piloting, lapping and grinding are reduced to the point of elimination.

These steels machine smoothly, accurately and uniformly in any type of lathe, milling machine, gear generating or broaching equipment. They are manufactured in various analyses suitable for regular hardening practice or salt bath.

If you use oil-hardening steel it will pay you to try TIMKEN Oil-Hardening Steel and get more and better parts with fewer rejects.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
STEEL AND TUBE DIVISION

Manufacturers of TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; TIMKEN Alloy Steels and Carbon and Alloy Seamless Tubing; TIMKEN Rock Bits; and TIMKEN Fuel Injection Equipment.

TIMKEN
ALLOY STEELS

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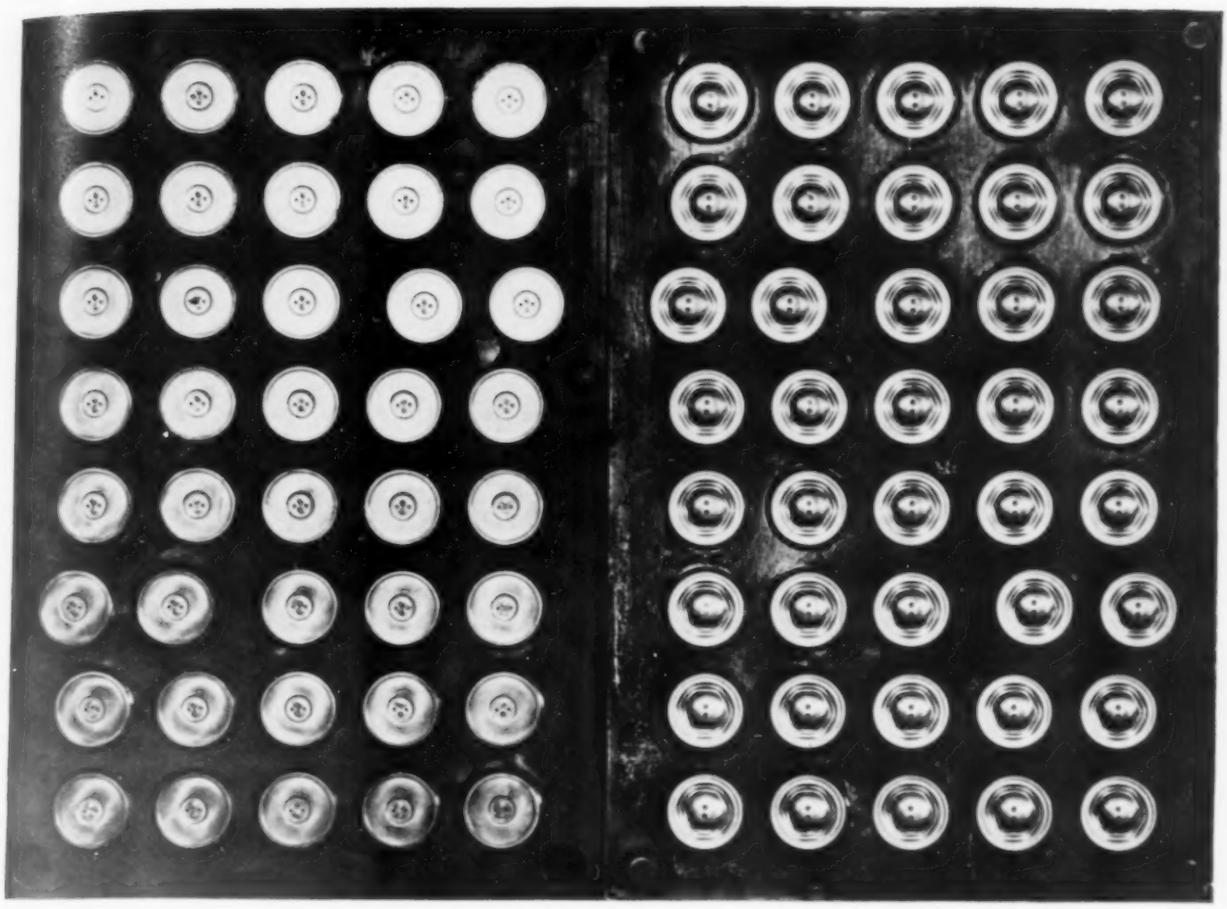


Vapocarb-Hump hardened molds for plastic buttons. Molds made by Fred Wacker Co., Long Island City.

Smooth! BECAUSE THEY'RE VAPOCARB-HUMP HARDENED

Made of low-carbon tool steel, and carburized in a Vapocarb-Hump Furnace at 1650 F., these button-molds need no finishing in the heat-treat—except a quick, light polishing.

Because, during hardening, they're protected by a Vapocarb atmosphere, they're as smooth when they leave the furnace as when they entered it. And because Vapocarb can be adjusted to supply carbon as plentifully as the heat-treater wishes, the mold's carburized case is of any required thickness.

The highly uniform distribution of heat in the furnace, plus the close, fully-automatic temperature control by the Micromax Pyrometer, holds molds accurately at carburizing heat and holds change in dimensions to the minimum. Molds can be single-quenched, double-quenched, or handled in any other way that gives best density, hardness and structure for long life.

Write For Catalog T-621

LEEDS & NORTHRUP COMPANY, 4927 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jri Ad T-621(19)

BASIC DOLOMITE, INC. now offers a full line of basic hearth refractories and plastics . . . from one central source

● Now, for the first time, the American steel industry has at its call from a single, close-at-hand, domestic source, a complete service on basic hearth refractories.

Through recent affiliation with Canadian Refractories, Ltd., we have added Basifrit and "695" Plastic to our line of Magnefer, Syndolag and Thomasite. These two well-known Canadian products will now come to you direct from our Maple Grove, Ohio, plant, strategically located at the heart of the steel industry.

Extensive additions and plant improvements nearing completion provide for production of our complete line and afford greatly enlarged capacity ample for future needs. Manufacture at this central location, entirely with American materials and labor, already has brought further product improvement and substantial price reduction.

With its many years of successful dolomite experience now supplemented by the similar intimate knowledge of magnesite practice of our Canadian affiliate, Basic Dolomite is in a unique position to extend a new type of dependable, impartial service to open hearth and other furnace operators. Where basic hearth refractories are required, "We've got everything."

BASIFRIT—The original quick-setting high-magnesia hearth refractory for both construction and repair.

THOMASITE—The new quick-setting hearth refractory with a still higher magnesia content.

"695" PLASTIC—The strong neutral refractory plastic for hot and cold furnace repairs.

MAGNEFER—The popular dolomite refractory for hearth and slag line maintenance.

SYNDOLAG—The special dolomite refractory, smaller in grain size than Magnefer, designed primarily for the electric furnace.

RAW DOLOMITE—Washed and carefully graded to specification.

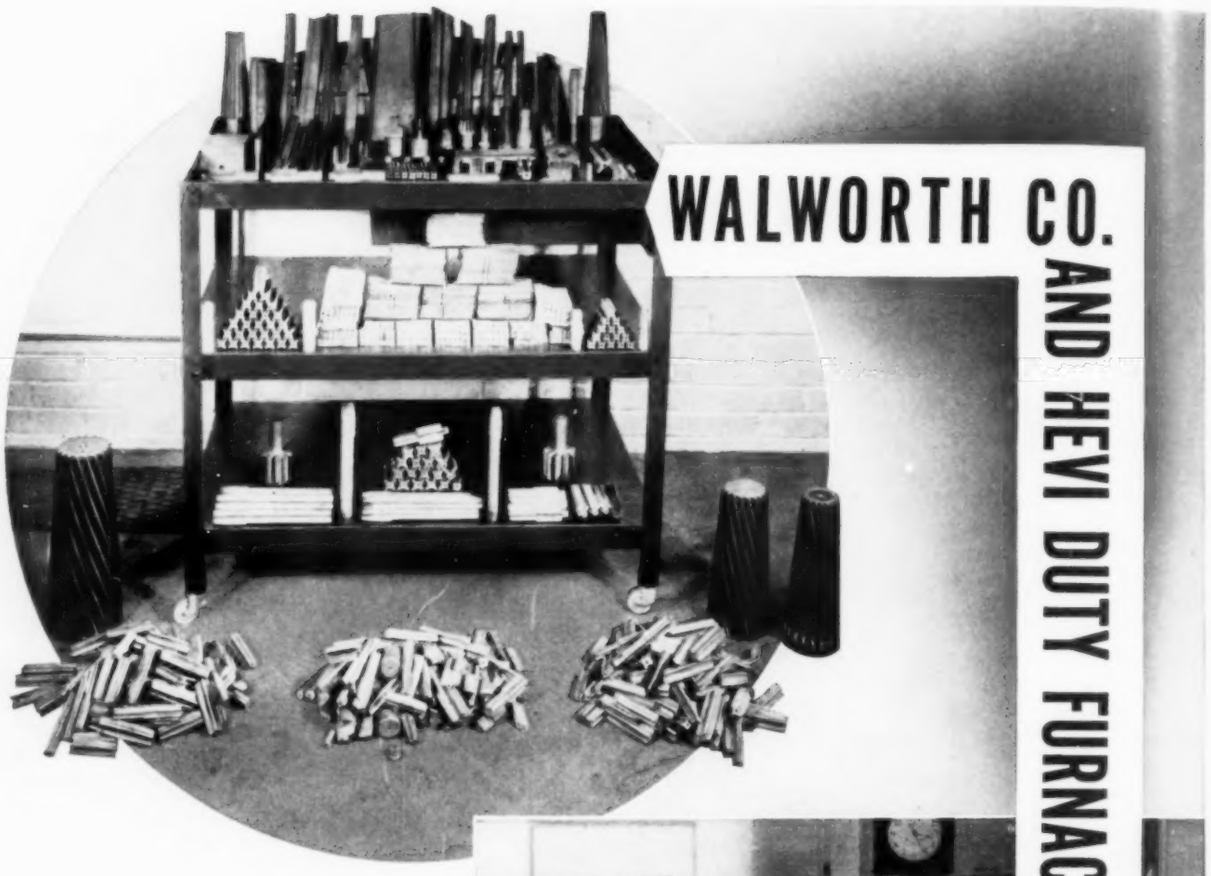
BASIC DO

BASIFRIT

THOMASITE

MITE INC.

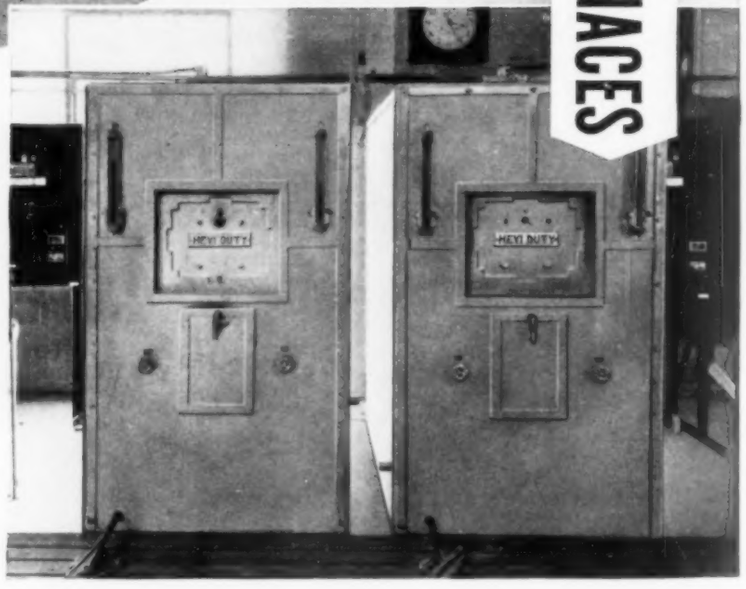
CLEVELAND



WALWORTH CO. AND HEVI DUTY FURNACES

A group of 18-4-1 high speed steel tools hardened in Hevi Duty Controlled Atmosphere Pre-heat and High Temperature Furnaces.

Quality products, such as Walworth Valves, require quality production tools. In the heat treatment of their production tools, the Walworth Co. use Hevi Duty Controlled Atmosphere Furnaces. They have found that, with gas curtain atmosphere control, scaling and decarburization have been cut to a minimum and that the even distribution of heat throughout the furnace chambers has materially reduced losses through cracking.



Hevi Duty Controlled Atmosphere Pre-heat and High Temperature Furnaces at the Walworth Company, Greensburg, Pa.

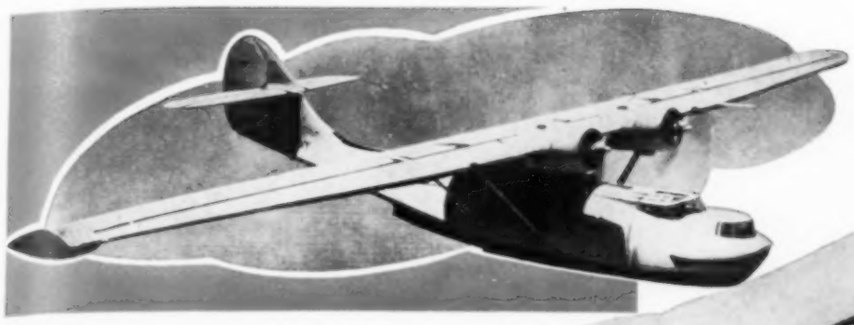
Send for Bulletin HD-338

HEVI DUTY ELECTRIC COMPANY

HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY

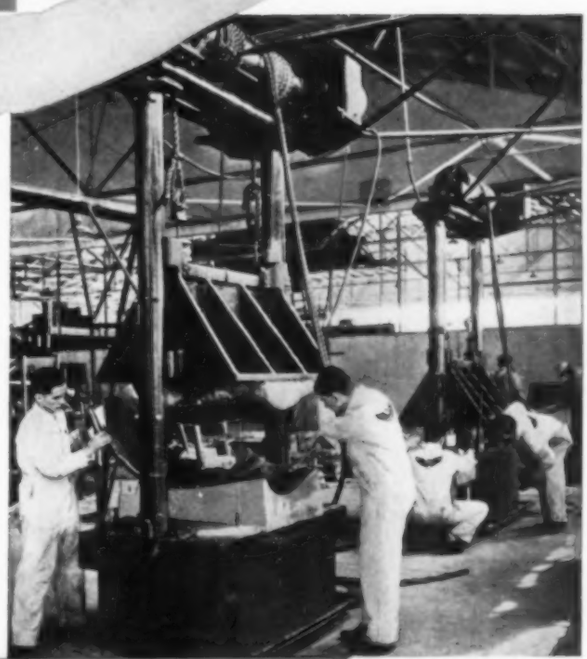
TRADE MARK REGISTERED U. S. PAT. OFFICE

MILWAUKEE, WISCONSIN



Lightness ALOFT

BUT ON THE GROUND— STURDY CASTINGS OF METAL MEEHANITE



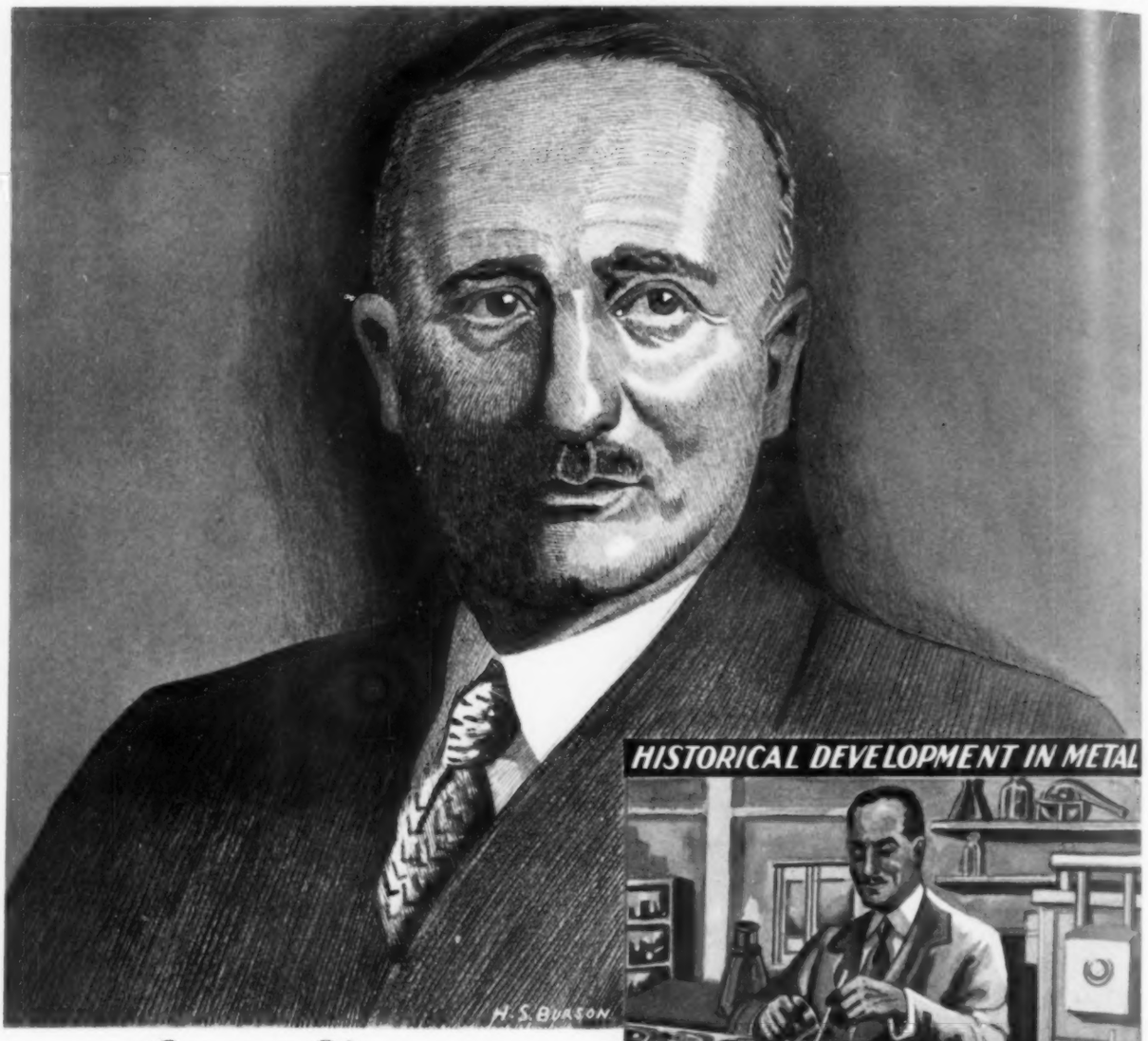
Drop hammers in the plant of the Ryan Aeronautical Company, San Diego, Calif., forming sheet-metal sections for airplane bodies to be used by Consolidated Aircraft Corporation. Hammer heads, formerly made of special steel, and also the bases, are now cast of MEEHANITE metal.

Shapely as a seagull, the body of a modern air-ship looks as if gently moulded by natural forces. But it is encased in no yielding material. The powerful "Consolidated" bomber that we see hovering over San Diego is sheathed in high-strength alloy sheets, formed into smooth-curving sections by drop hammers that give and take tremendous shocks. Hammer and base are of MEEHANITE, a special and superior processed iron. MEEHANITE has high tensile strength—up to 60,000 pounds as cast, 70,000 pounds when heat-treated. It can be made to afford great impact strength, damping quality, toughness, and machinability. Corrosion-resistance, heat-resistance, and abrasion-resistance to an extraordinary degree can be provided. The behavior of MEEHANITE in the molten state gives a smooth, well defined casting, remarkable for uniformity of structure through both thin and heavy sections of even the most intricate parts. For specification data, address any of the licensed manufacturers listed below, or Meehanite Research Institute, Vandergrift Bldg., Pittsburgh, Pa.

MANUFACTURERS:

American Laundry Machinery Co.	Rochester, N. Y.
Atlas Foundry Co.	Detroit, Mich.
Banner Iron Works	St. Louis, Mo.
Barnett Foundry & Machine Co.	Irvington, N. J.
H. W. Butterworth & Sons Co.	Bethayres, Pa.
Cincinnati Grinders Incorporated	Cincinnati, Ohio
The Cincinnati Milling Machine Co.	Cincinnati, Ohio
Cooper-Bessemer Corporation	Mt. Vernon, Ohio
M. H. Detrick Co.	Peoria, Ill., Newark, N. J.
Farrel Birmingham Co.	Ansonia, Conn.
Florence Pipe Foundry & Machine Co.	R. D. Wood Company, Philadelphia, Selling Agents
Fulton Foundry & Machine Co.	Cleveland, Ohio
General Foundry & Mfg. Company	Flint, Mich.
Greenlee Foundry Company	Chicago, Ill.
Hamilton Foundry & Machine Co.	Hamilton, Ohio
Kanawha Manufacturing Co.	Charleston, W. Va.
Kinney Iron Works	Los Angeles, Calif.
Koehring Company	Milwaukee, Wis.
E. Long, Ltd.	Orillia, Canada
Rosedale Foundry & Machine Co.	Pittsburgh, Pa.
Ross-Meehan Foundries	Chattanooga, Tenn.
The Stearns-Roger Mfg. Co.	Denver, Colo.
Vulcan Foundry Company	Oakland, Calif.
Warren Foundry & Pipe Corp.	Phillipsburg, N. J.
Washington Iron Works	Seattle, Washington
Australian Meehanite Metal Co., Ltd.	Waterloo, N. S. W.
The International Meehanite Metal Co., Ltd.	London
Meehanite Metal Corporation	Pittsburgh, Pa.

Pioneers in Industrial Science



Benno Strauss

From 1909-1912, Benno Strauss and Eduard Maurer experimented with high chrome-nickel alloys in the Krupp works laboratory at Essen, Germany, seeking a suitable material for pyrometer tubes. Corrosion tests showed that the 20% chromium alloys remained bright, while 25% nickel compositions, had become rusty. This resulted in the patenting of two groups, (.25% carbon, 20% chrome—7% nickel) (.15% carbon, 14% chrome—1.8% nickel), which were later developed into what we know today as Stainless Iron and Steel.

The role of pioneers in stainless and heat-resisting alloys, would not be complete without proper mention of such names as Becket, Maurer, Brearley, Haynes, Armstrong, Johnson and Marsh.

THERMALLOY *the "EYE" of QUALITY*
THE ELECTRO ALLOYS COMPANY
CASTINGS FOR HEAT CORROSION
ELYRIA, OHIO

Hydryzing

View of Preheat and High Speed Hydryzing Furnaces in Operation at Acme Steel Treating Co., Detroit.

When you buy steels for your tools and dies you are generally buying *surfaces* and *cutting edges*. If heat treatment results in decarburization or "soft skin" you are not getting the steel you paid for in those surfaces and cutting edges. Faulty heat treatment has decarburized them, robbed them of carbon content, of hardness, and ability to stand up and take abuse.

The Hydryzing Process for heat treating steels prevents decarb. It brings your work out with hard surfaces and edges. In addition scaling and carburizing are prevented. Regardless of the type of steel or temperature, whether low carbon, high carbon or high speed, there is no change in furnace atmosphere. Check up on Hydryzing by sending us several samples of your work *today*. We'll Hydryze and return them immediately, without obligation.

LINDBERG ENGINEERING COMPANY

221 NORTH LAFLIN STREET • CHICAGO

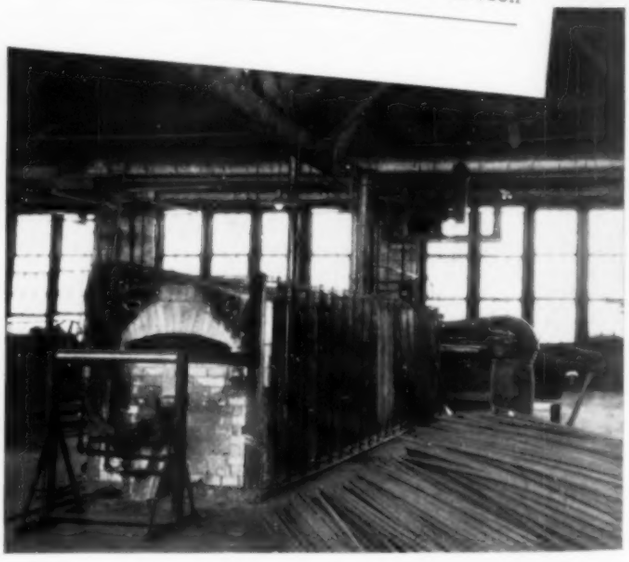
Lindberg *Furnaces*

WHAT HAPPENS when you replace a fireclay hearth with "CARBOFRAX"

HERE'S WHAT HAPPENED IN A MIDWESTERN MALLEABLE IRON FOUNDRY

OPERATING RESULTS

	With Fireclay Hearth	With "Carbofrax" Hearth
Time required to bring furnace to operating temperature	6 hours	4 hours
Scaling in heating period	Considerable (due to longer time in furnace)	None
Production in 8 hr. period	9 tons	11 tons (22% increase)
Life of hearth	2 weeks	2 months (300% increase) Still in good condition



● This midwestern malleable iron company replaced a fireclay hearth with "Carbofrax" in a furnace used for heating bars for forging.

The foregoing report tells the whole story of the savings they have made.

Operation—Furnace operated at 1850°F. to heat low carbon bars 28 ft. x 7/8 in. x 3/4 in. to forging temperature for manufacture of rail anchors. Bars weigh 60 lbs. each. A furnace load is eight bars and as one is drawn a cold bar is charged. The hearth is 30 ft. long, 2 ft. 6 in. wide. With fireclay the floor was 4 in. thick. Because of its greater strength, even at high temperatures, a "Carbofrax" floor 2 in. thick carries the same load satisfactorily.

Naturally, they're enthusiastic about "Carbofrax" hearths. Similar savings can be made in YOUR heating and heat-treating operations by utilizing the high heat conductivity, the great strength and the resistance to cracking and abrasion of "Carbofrax" hearths.

Refractory representatives in the offices listed will be glad to make a survey for you.

REFRACTORY CARBORUNDUM PRODUCTS

THE CARBORUNDUM COMPANY, REFRACTORY DIVISION, PERTH AMBOY, N. J.
REG. U. S. PAT. OFF.

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. Agents: McConnell Sales and Engineering Corp., Birmingham, Ala.; Christy Fire Brick Company, St. Louis; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle; Denver Fireclay Co., El Paso, Texas

(Carborundum and Carbofrax are registered trade-marks of The Carborundum Company)

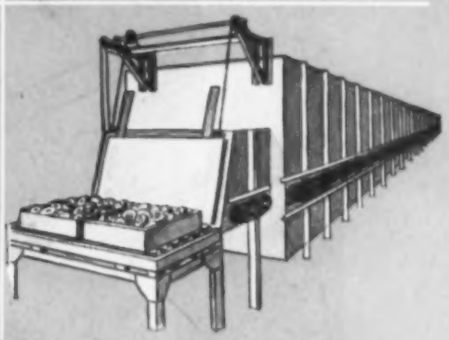
1 THE CASE When properly annealed, malleable castings have a tensile strength of more than 50,000 pounds per square inch and elongation of 10 to 18 per cent in two inches. Experts have spent much time seeking the best way to attain these characteristics.

2. THE OLD WAY Previously, castings were loaded into cast boxes or pots. Metal chips were packed around them to afford some protection against oxidation and warpage. This method, while necessary, wasted heat—and dragged out the time needed for heating and cooling.

3. THE NEW WAY In a modern G-E roller-hearth furnace, the castings can be loaded on light trays and carried through set time-temperature cycles. The product is consequently uniform for it is all treated alike. The dead weight of pots and packing is eliminated.

4. SAVES MONEY Experience has proved that the change to trays accounts for a saving of $3 to $5 a ton because high maintenance expense on pots is gone and heat is conserved. With a production of 75 to 100 tons a day, a user saves more than $225 a day!

5. SAVES TIME Not long ago, annealing took 5 to 10 days. Now G-E furnaces take 14 to 32 hours. With a 7-day cycle and production of 100 tons a day, 700 tons of work are tied up. At $150 a ton, that's $105,000. With a 1 1/2-day cycle, 150 tons, or $22,500, is tied up. Operating capital is reduced $82,500 a year. At 4 per cent, that's $3,300 saved.



6. THE EQUIPMENT In addition to roller-hearth furnaces, G-E offers pusher-tray and batch-type furnaces for short-cycle annealing. All afford lower operating cost, shorter cycles, and uniform products.

Cut Cost of Malleable Annealing

$3 TO $5 A TON BY USING A

General Electric Furnace

BENEFIT IN THESE TWO WAYS BY USING ELECTRIC HEAT

YOU can benefit (1) by reducing the over-all cost of heat-treatment; and (2) by improving the quality of your product.

As evidence of the first benefit, consider this: the average annual return on the money invested in G-E heat-treating equipment used in eight recent installations is 145 per cent.

Let us prove the second benefit to your satisfaction by testing samples of your product in our Industrial Heating Laboratory. Our engineers, who are backed by 20 years of experience in this field, can, in the majority of cases, predict the outcome without a test. If your problem is at all unusual, however, they will run tests with the samples. There is a small charge for test work, but it is refunded if you purchase a G-E furnace.

Take the first step toward the realization of these benefits by arranging—now—for sample tests. Call the nearest G-E sales office or write General Electric, Schenectady, New York.

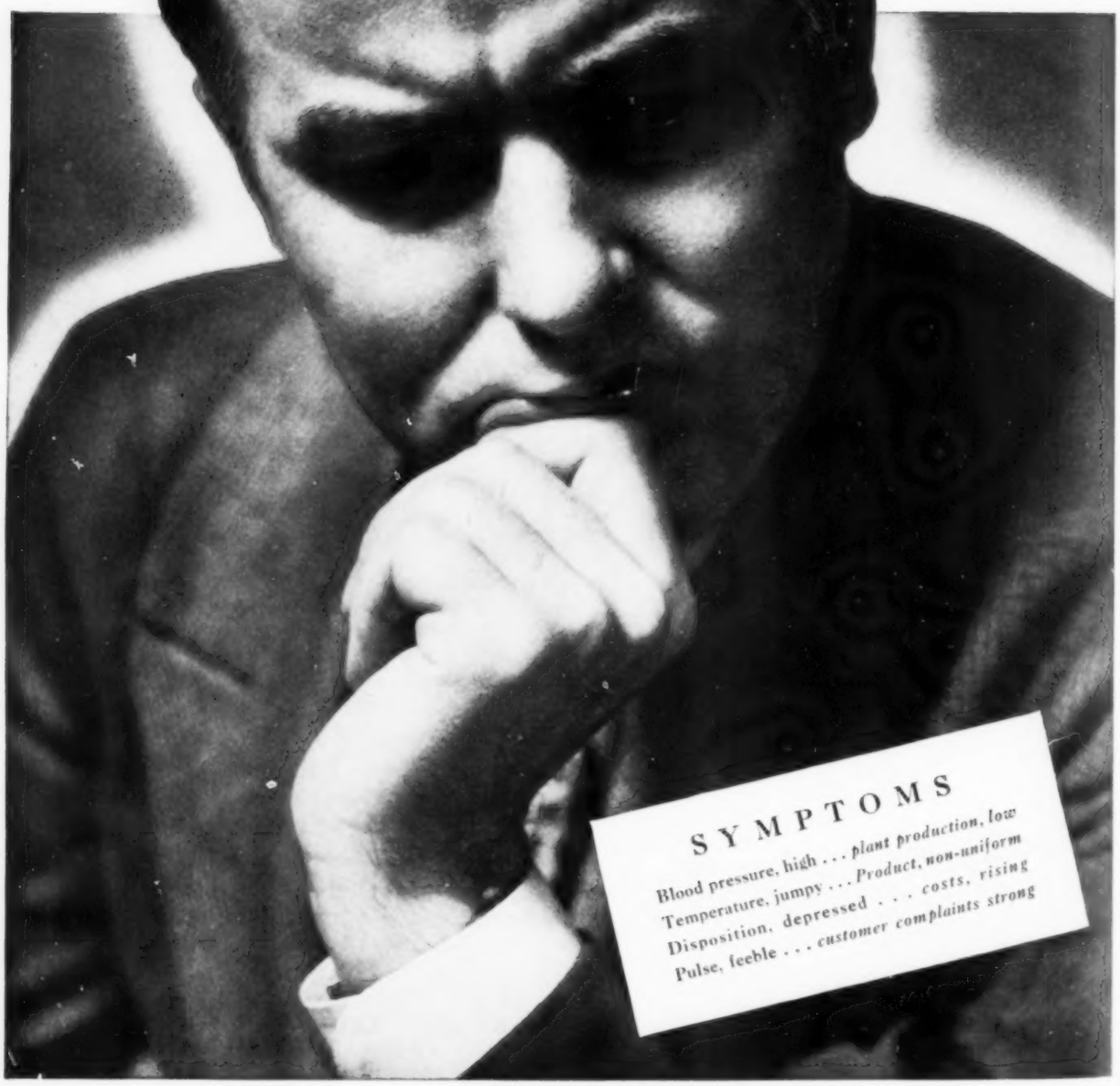
Write to Room 3196, Building 6, G.E. Co. Schenectady, for FREE material showing G-E furnaces and how they make savings

GENERAL ELECTRIC PROVES FURNACE PERFORMANCE BY LABORATORY TESTS

GENERAL ELECTRIC

160-76

Works Manager


SYMPTOMS
Blood pressure, high . . . plant production, low
Temperature, jumpy . . . Product, non-uniform
Disposition, depressed . . . costs, rising
Pulse, feeble . . . customer complaints strong

Metal Progress; Page 636

. . . Age 36

—looks 50 feels 100!

HERE is a man suffering from a bad case of "non-uniform-itis." Variations in the steel he is using are playing hob with his production, with his product, with his costs and with his disposition.

Chances are he has never given U·S·S Controlled Steels serious consideration. Doesn't know how these steels — in which all properties are kept consistently uniform — have cured other situations far worse than his.

We offer these testimonials:

In one plant making nuts and bolts, their use of U·S·S Controlled Steel has increased production per machine from 4000 lbs. of nuts per day to 8000 and 11,000 lbs. With one punch they obtain 20,000 nuts instead of 3000. With one set of dies they now process 140 tons as compared to 10 or 20 tons previously.

. . .

An agricultural chain manufacturer is reeling up miles of finished chain made to very restrictive physical properties. States that his use of U·S·S Controlled Steel has increased the physical properties of his chain at least 25%—with no increase in cost.

. . .

A ball bearing manufacturer writes us that he is making a better and more uniform ball bearing race than ever before, because U·S·S Controlled Steels give him exact control of hardness penetration, distortion and other factors of carburizing operations.

. . .

A prominent gear manufacturer using U·S·S Controlled Steel specifies fine grain structure in one size and coarse grain in another—and gets it. Now obtains a uniformly hardened product, with a single, standardized, heat-treating schedule.

. . .

A heat-treater reports that he is able to reduce cold straightening with a resultant marked improvement in fatigue-life. Of special importance because it was not possible or economical to submit the parts to a sub-critical stress-relieving anneal. Careful selection of the proper grade of uniform U·S·S Controlled Steels reduces his warpage and distortion to a clearly defined, consistent minimum.

In all these applications, the success of U·S·S Controlled Steels in increasing product quality, in smoothing out processing difficulties and in reducing cost is due to one important fact. They offer the user plain carbon steels for forging, forming, heat-treating and machining in which *all* quality factors are definitely predetermined and kept consistently uniform, shipment after shipment. Precisely controlled analyses and grain structure eliminate those mysterious differences which make it so difficult to obtain consistently uniform results with ordinary steels.

Why not invite one of our metallurgists to look over your production line. Let him prescribe Controlled Steels where he thinks they will do you the most good.

U·S·S Controlled Steels

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Spencer Turbos at Work

SPENCER TURBOS ON "THE ELECTRIC FURNACE COMPANY" EQUIPMENT

The Electric Furnace Company of Salem, Ohio, builders of Electric and Fuel Fired Industrial Furnaces, is another of the prominent furnace companies which has used Spencer Turbos for years on their furnace equipments.

Several recent installations showing their furnaces equipped with Spencer Turbos are shown at right.

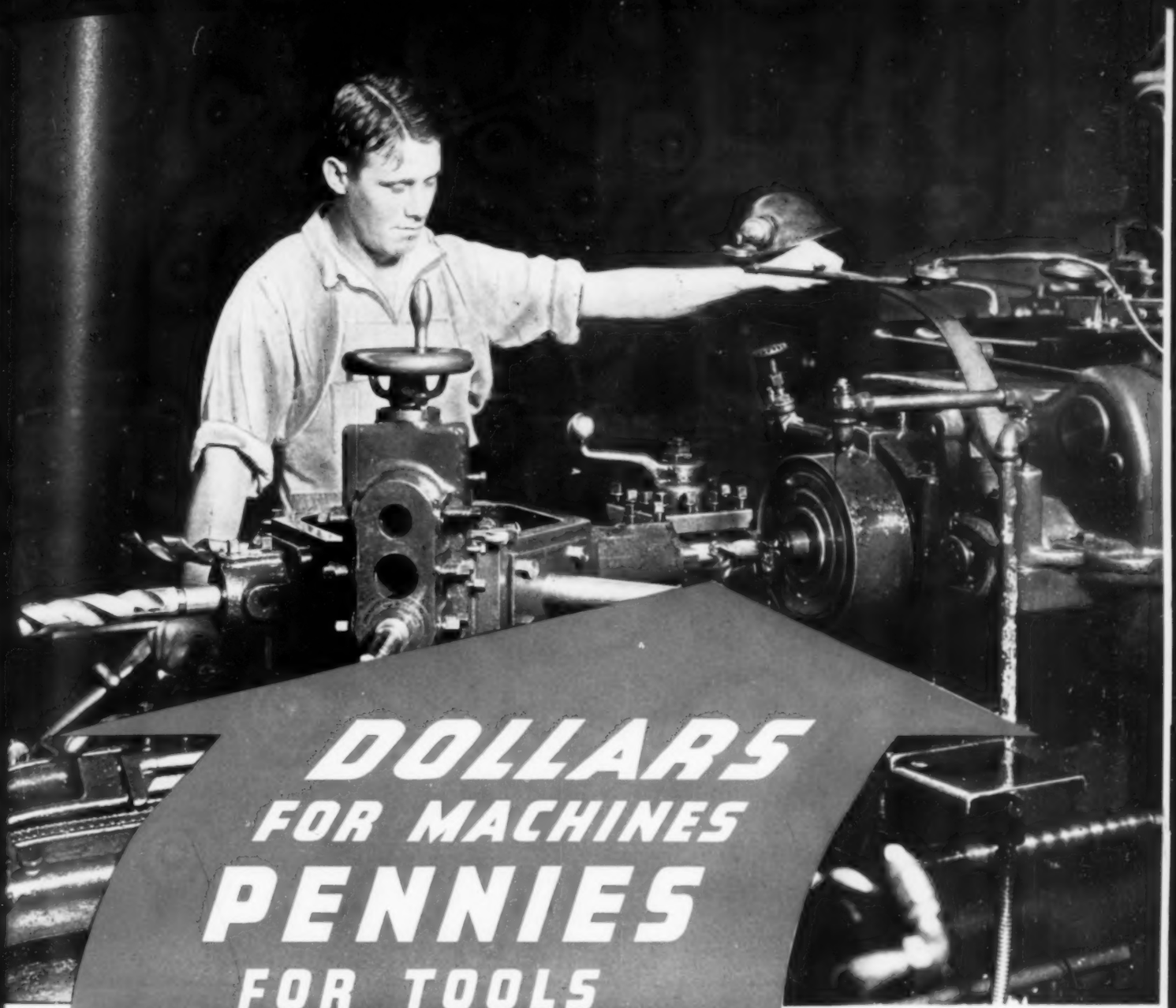
Spencer Turbos were selected for these furnaces because they can be depended upon to stand up and deliver steady air pressure day after day, quietly and with practically no maintenance expense or attention other than oiling.

126-C

THE SPENCER TURBINE COMPANY • HARTFORD, CONNECTICUT

SPENCER HARTFORD TURBO-COMPRESSORS

35 TO 20,000 CU. FT. 1/3 TO 300 H. P. 8 OZ. TO 5 LBS.



DOLLARS FOR MACHINES PENNIES FOR TOOLS

Even the costliest and most efficient machine tool is limited in its performance by the kind of cutting tools used. Increase the return on your machine tool investment by using tools of MO-MAX Molybdenum Tungsten High Speed Steel.

They increase production per tool 15 to 20 per cent over 18-4-1—and the tools cost no more. They are easier to forge and grind—and require eight per cent less steel.

For facts and figures, see this book. Write for a copy to Cleveland Twist Drill Company, Cleveland, Ohio.

FOR QUANTITY AND QUALITY PRODUCTION . . . SHIFT TO . . .

MO-MAX* MOLYBDENUM TUNGSTEN HIGH SPEED STEEL

TRADE MARK REG U.S. PAT OFF

*MO-MAX is a proprietary name owned and controlled by The Cleveland Twist Drill Company, and its only licensed use by others is on steel made and sold by licensees under patents owned or controlled by said Company.

8755

Look for the answer to metal-working problems in

Alcoa Aluminum Alloys

Rotors being "assembled" by die-casting Alcoa Aluminum Alloys.

BASED ON the fact that electrical conductivity of Aluminum varies according to the alloy, motor manufacturers obtain different starting characteristics in squirrel-cage motors with apparently identical rotors. The production of these rotors by the die-casting method is pictured here. Molds and casting procedure remain the same; simply the Alcoa Aluminum Alloys are changed.

You can make the alloys of Alcoa Aluminum work for you. Available in every commercial form, they provide a wide range of possibilities, and can be fabricated by standard metal-working methods.

Hydraulic extrusions offer unique design advantages. Alclad* products have extremely high resistance to corrosion. Alumilite* finished products provide colors and good resistance to abrasion. Pressings open up new economies in fabrication. Alcoa screw machine stock permits a substantial increase in cutting speeds. And Aluminum has many other desirable properties.

For data on all the properties and commercial forms of Aluminum, write for the booklet, "Alcoa Aluminum and Its Alloys." There is a *best* alloy for each purpose. ALUMINUM COMPANY OF AMERICA, 2101 Gulf Building, Pittsburgh, Pennsylvania.

*Patented

MADE *Economically* OF ALLOYS OF ALCOA ALUMINUM

ALCOA · ALUMINUM

There are many good reasons for changing to *Aluminum Die Castings*

Showing fineness of finish and detail obtained with Alcoa Aluminum Die Castings.

DIMENSIONS of Alcoa Aluminum die castings are stable; there's no tendency for the metal to "grow," even when subjected to high temperatures. Witness the perfect performance of Aluminum equipment in the hot, moist atmospheres of processing plants. And the continued, smooth operation of closely-fitted parts exposed to the heat and high humidity of the tropics. You can depend upon Alcoa Aluminum die castings to retain their original shape and size.

The superior heat conductivity of Aluminum is a valuable asset where heat distribution is a problem. Aluminum can be given a wide variety of attractive surface finishes and, even when working at temperatures of several hundred degrees, it retains its fine appearance.

With Aluminum die castings, you get the combined weight savings resulting from the natural lightness of Aluminum and the thinner sections possible in the die-casting method.

Aluminum, of course, is resistant to corrosion. All of the advantages of die casting are retained with Aluminum: parts can be quite intricate, surfaces fine and dimensions accurate, thereby eliminating many expensive, tedious assembly and machining operations. ALUMINUM COMPANY OF AMERICA, 2101 Gulf Building, Pittsburgh, Pa.

MADE *Economically* OF ALLOYS OF ALCOA ALUMINUM

ALCOA · ALUMINUM

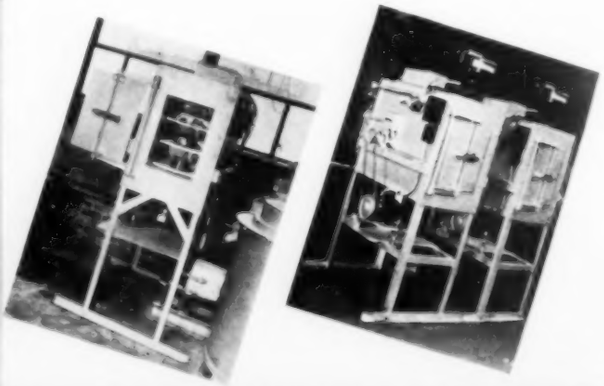
ALCOA ALUMINUM

A CYCLONE FOR EACH!

PRODUCTION TEMPERING .... AND TOOL ROOMS

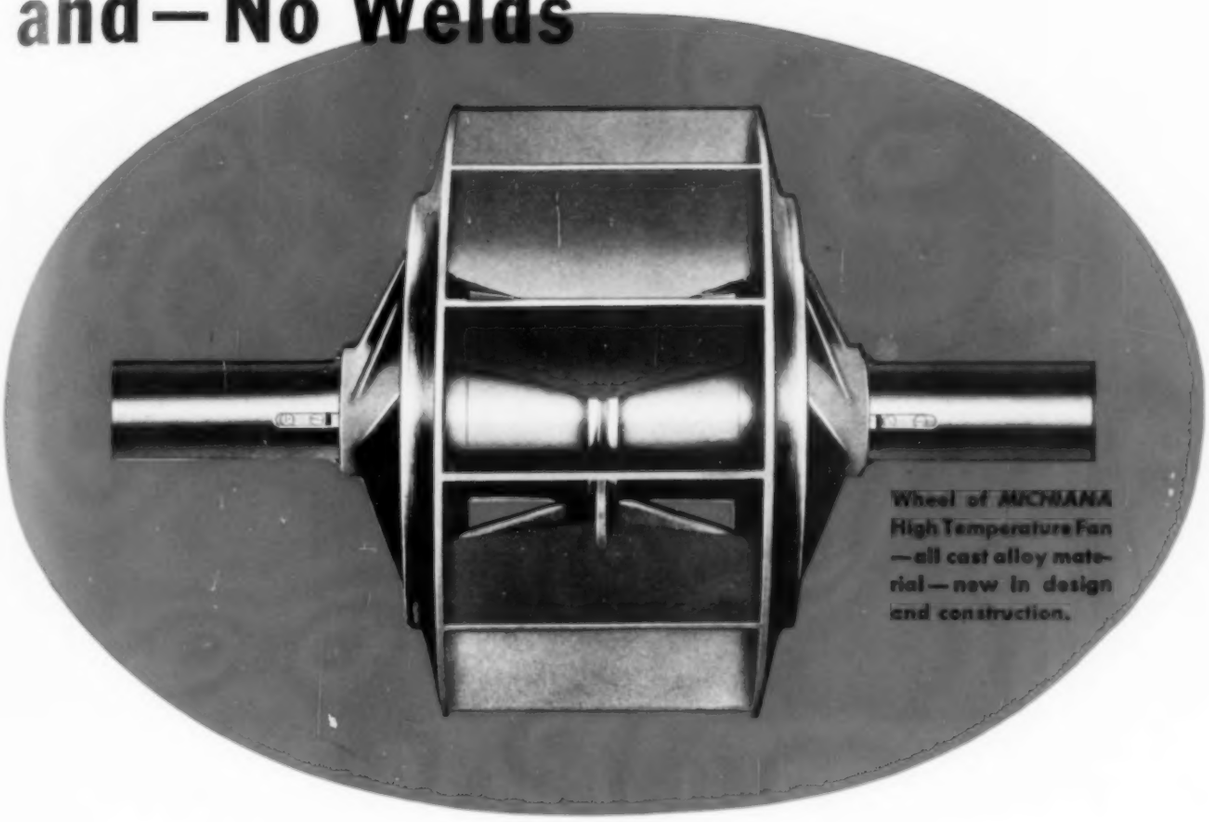
THE *vertical* Cyclone Tempering Furnace is used primarily on the *production* line for tempering light and heavy loads with equal facility—equal accuracy. Work is handled in baskets as illustrated, and plus or minus 1-point Rockwell "C" is the usual specification for Cyclone Tempered work. Profit by this precision in your own plant—save through Cyclone economies. Cyclones are built for either gas or electric heating. Accuracy of control is common to both.

TOOLS, DIES, and small production jobs are conveniently and accurately tempered in this Box Type Cyclone Tempering Furnace. Parts can be placed directly on the grids as shown or into small mesh trays. All parts are visible when the door is opened and any can be removed prior to others. Temperatures are quickly changed—and, of course, the Box Cyclone utilizes the same famous heating principle as the vertical production Cyclone. Temperature range is to 1250° F. Write today for literature on either the vertical or tool-room Cyclone. Address Lindberg Engineering Co., 221 North Laflin Street, Chicago.



LINDBERG ENGINEERING CO.
222 N. LAFLIN STREET CHICAGO, ILLINOIS

No Screws, No Bolts, No Rivets and—No Welds



Wheel of *MICHIANA* High Temperature Fan —all cast alloy material—new in design and construction.

In the vital parts of ***MICHIANA*** High Temperature Fans the design eliminates entirely the use of screws, bolts, rivets and welds. . . . Further — it permits free and independent expansion of those parts radially and axially. . . . They meet the need for fans that will stand up in applications where extremely high temperatures are encountered. . . . The alloys used—***MICHIANA*** Heat-Resistant Castings —have been successfully applied in industry for over 20 years.

Let us mail you our new Bulletin 638 and capacity data.

MICHIANA PRODUCTS CORPORATION
Michigan City, Indiana

MICHIANA
HIGH TEMPERATURE
FANS

Write for Bulletin 638

One way to MODERNIZE *your tool room without spending a cent*

New equipment is not the only way to bring modern money-saving methods to your tool room. Whether your equipment is old or new you can effectively apply the Matched Set Method of Tool Steel Selection. This proven Carpenter procedure makes it easy to lower tooling costs and bring tool performance in line with latest practice.

For instance, suppose you want greater wear resistance in an intricately shaped forming die. The Matched Set Method helps single out the best tool steel to use almost as fast as you can name the specialized requirements of the tool.

Furthermore, you have in black and white exact heat treating information and complete working data on the steel. In no case does this method involve a radical departure from those tool making practices with which you are already familiar.

Because it is based as much on *your* knowledge of tool making as on our knowledge of tool steel, you will find this unique method easy and safe to use.

To introduce this method to you we have prepared a convenient, immediately useful Wall Chart. It will help you put your finger on the right tool steel for every job and indicate how you can avoid mysterious tool failures.

Write today for your copy of Carpenter's large Tool Steel Selector Wall Chart. Without cost or obligation, you can take this easy step toward better tools and modern tool making methods.

THE CARPENTER STEEL COMPANY
READING . . . . . PENNSYLVANIA

Carpenter MATCHED

The Tool Steel Selector
for use in your tool room
A READY REFERENCE CHART OF CARPENTER MATCHED TOOL STEELS TO HELP YOU PICK THE RIGHT TOOL STEEL FOR EACH JOB
THE OIL-HARDENING MATCHED SET
THE WATER-HARDENING MATCHED SET
THE RED-HARD MATCHED SET
K-W WATER-WEAR
STAR-ZENITH RED-WEAR
D.Y.O. RED-HARD
SPECIAL WATER-HARD
EXCELO RED-TOUGH
SOLAR WATER-TOUGH
GREATER WEAR RESISTANCE
GREATER TOUGHNESS
GREATER RED-HARDNESS
GREATER HARDENING ACCURACY AND SAFETY
When to Use an Oil-Hardening Steel
When to Use a Water-Hardening Steel
When to Use a Red-Hard Steel
HOW TO US
STEEL SELECTOR

THE PROBLEM—Twenty feet of wire per minute slides over this little mandrel which spaces the wire to form flexible steel cable. The metal-to-metal sliding action galled every tool steel tried.

THE SOLUTION—A mandrel was made from Carpenter K-W—the slippery-hard tool steel. It resisted wear so successfully that K-W mandrels have been doing the job ever since. They give three to four times the life of anything ever used before. Have you a galling problem for K-W to solve?

THE PROBLEM—This transfer finger has to pick up the work—hold it tight for accurate machining—then eject it—and do this 40,000 times a day. Steel after steel was tried to get away from repeated breakage of the transfer fingers. None were tough enough to last more than a few hours.

THE SOLUTION—Someone suggested Carpenter *Solar* tool steel. Its bulldog toughness overcame the trouble. Solar transfer fingers are giving upwards of *two months* service—and hitting the *three million* mark in production. Where can you use the toughness of Solar?

TOOL STEELS

THIS WALL CHART *FREE*
TO TOOL STEEL USERS IN U. S. A.

THE CARPENTER STEEL COMPANY
133 W. BERN STREET • READING, PA.

Please send me free, and without obligation, a copy of your large Wall Chart Tool Steel Selector.

NAME_____

TITLE_____

FIRM_____
Firm name must be given

ADDRESS_____

CITY_____ STATE_____

"ROCKWELL"
SUPERFICIAL
HARDNESS TESTER

For
Thin
METAL
•
Soft or Hard

SCHICK Dry Shaver, Inc. had the problem of precision production testing of their shearing heads of thin hard steel for the purpose of insuring a nice, heat-treating job on each and every one of their shavers. They selected the "ROCKWELL" Superficial Hardness Tester for testing these very thin parts four years ago. Two years later they ordered a duplicate. THEY HAVE FOUND THESE MACHINES THOROUGHLY DEPENDABLE.

379 Concord Ave.
New York

WILSON
MECHANICAL INSTRUMENT CO., INC.

Only Wilson
makes the
"ROCKWELL"
HARDNESS TESTER

For
Nitrided
STEEL
•
All Shallow Tests

"ROCKWELL"
SUPERFICIAL
HARDNESS TESTER

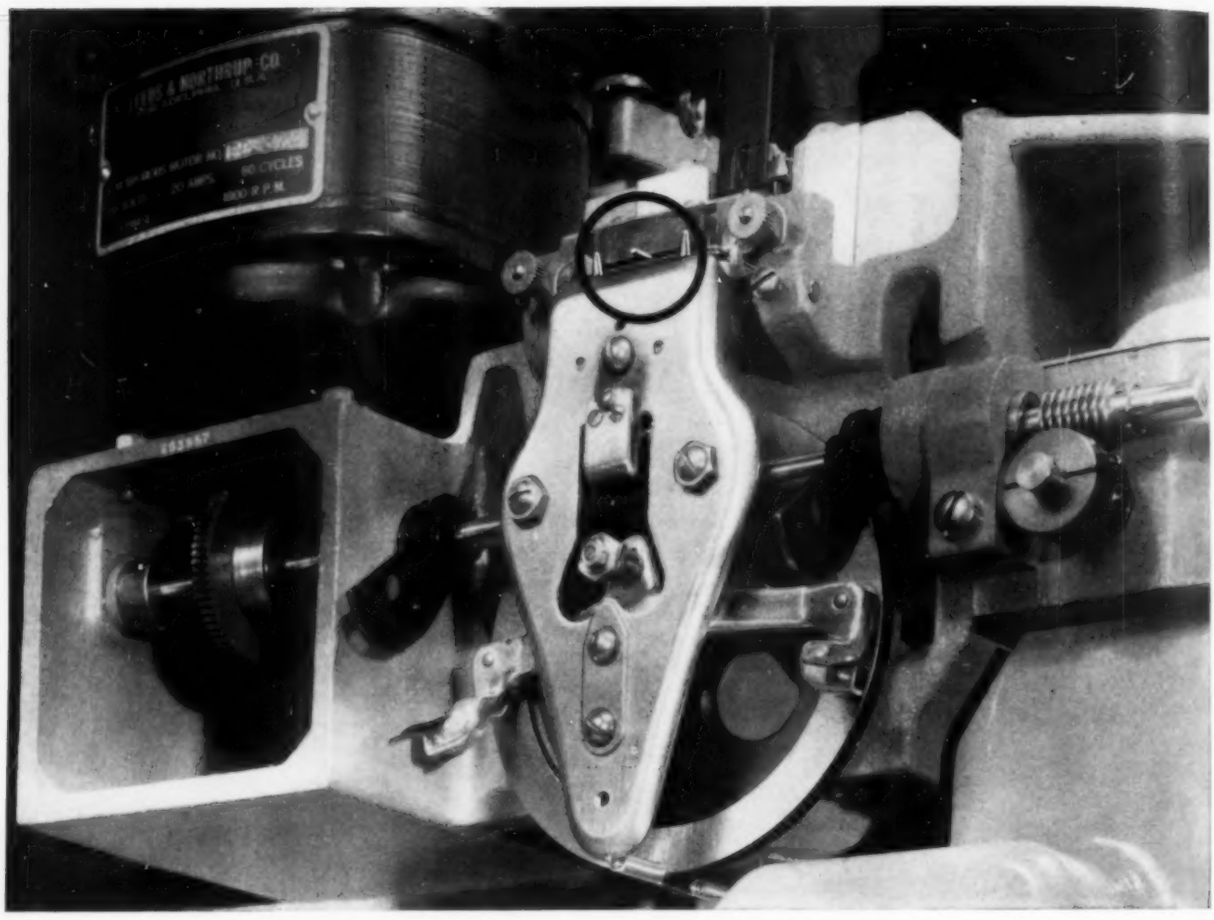
This photograph is actual size

THE DeVilbiss Company, four years ago, ordered one of these "Superficial" type "ROCKWELL" Testers for general use where indentation tests had to be exceptionally shallow. For testing nitrided spray gun fluid tips this tester has for some time, in addition to other jobs, enabled them to hold these parts to within 70-80 on the 30 N scale of the "Superficial" machine. The nitriding is done to produce a case approximately .007" thick. THOSE WHO TEST THEIR PRODUCT ARE NOT AFRAID OF THE TRUTH.

Only Wilson makes the "ROCKWELL" HARDNESS TESTER

WILSON
MECHANICAL INSTRUMENT CO., INC.

379 Concord Ave.
New York



Balancing Mechanism of Micromax Recording Controller

Micro-Responsive MICROMAX

PUTS ITS FINGERS ON TEMPERATURE'S PULSE

The Micromax Pyrometer's micro-sensitive, no-clearance Balancing Unit does something of unique benefit to every temperature-recording or controlling problem. . . . Because of it, the Micromax temperature-driven needle *can't move* without the motion being acted on. The appropriate response of fuel valve, recording pen and indicating pointer takes place whenever temperature affects the needle . . . however slightly. Micromax acts early, sets new standards, for recording and for control.

LEEDS & NORTHRUP COMPANY, 4927 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad N33(26)

PRODUCED BY AN ORGANIZATION MAKING STAINLESS STEELS EXCLUSIVELY

RUSTLESS

RESILIENCE WAS THE PROBLEM IN PRESSING PADS . . . WHAT'S YOURS?

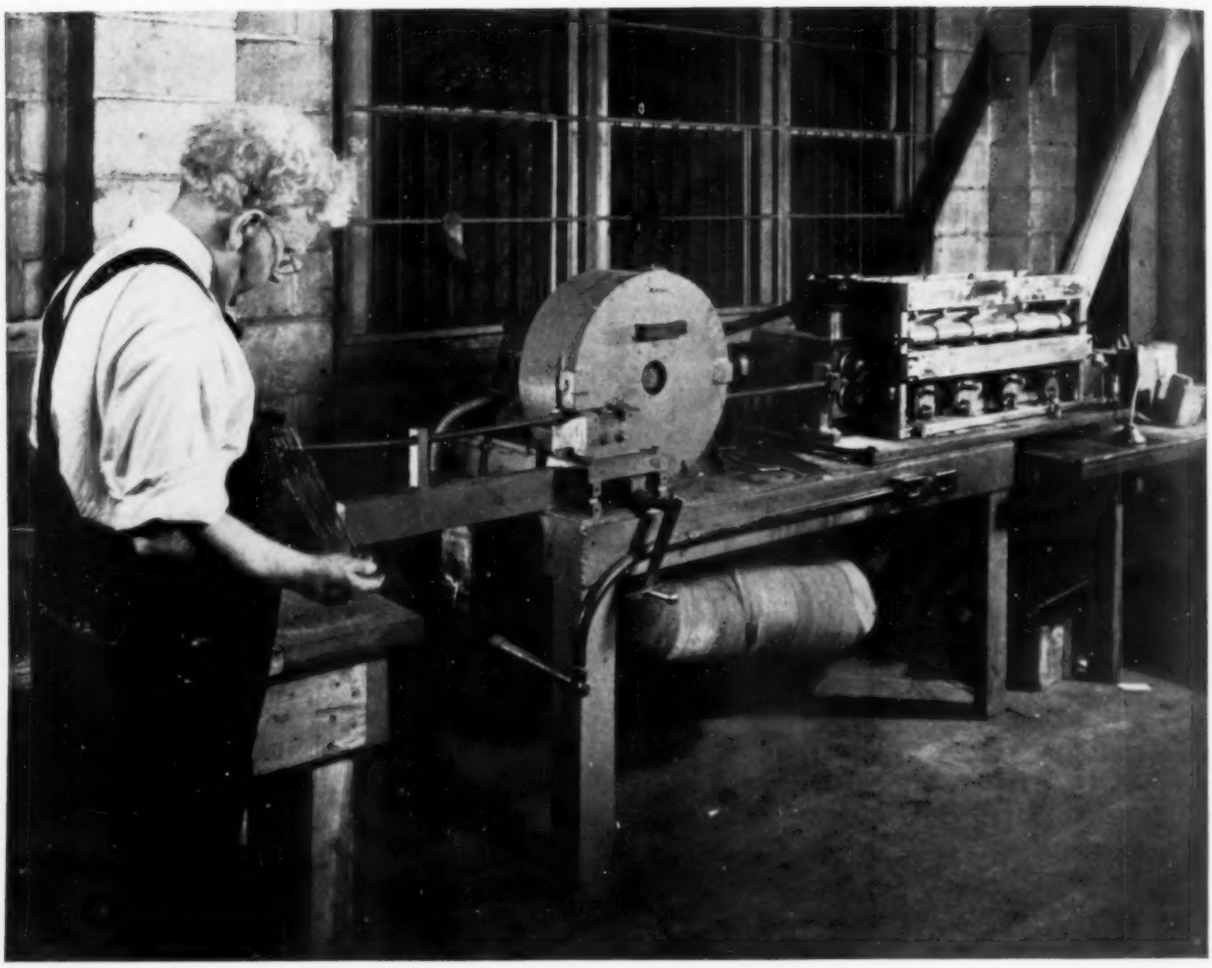
Your product is different . . . but there may be a profitable idea for you in this story. Pressing machine pads must resist corrosion, while retaining resilience . . . a combination provided only by stainless steel wool. The manufacture of this wool demands exceptional uniformity and finish in the stainless used . . . a combination thus far provided only by Rustless.

Rustless specialization on the one job of making stainless steel permits full-time concentration on customers' problems . . . with results as suggested above. May we discuss with you the possibilities of using Rustless in your product?

RUSTLESS IRON AND STEEL CORPORATION · BALTIMORE · MD.
Producing Stainless Steels Exclusively

RUSTLESS
STAINLESS STEEL
BARS AND WIRE

SALES OFFICES: **CHICAGO**—4201 IRVING PARK ROAD · **CLEVELAND**—731 SOCIETY FOR SAVINGS BUILDING · **DETROIT**—4-137 GENERAL MOTORS BUILDING · **PHILADELPHIA**—1263 COMMERCIAL TRUST BUILDING · **DISTRIBUTORS IN PRINCIPAL CITIES**



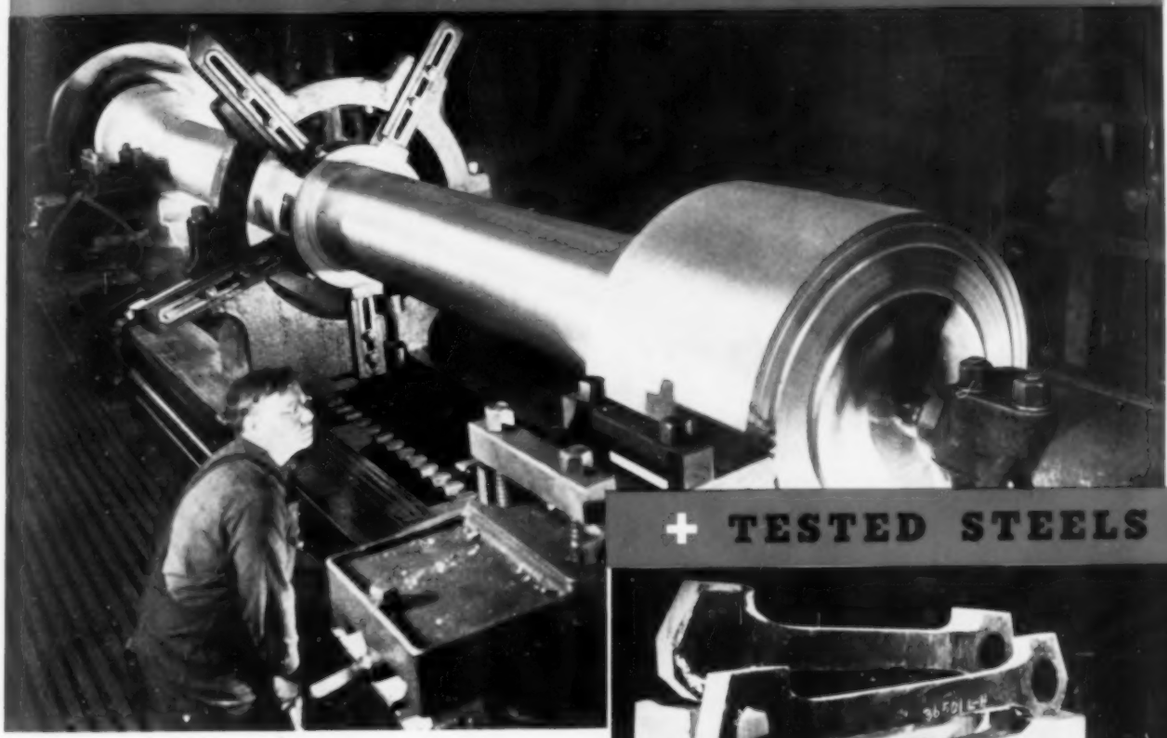
Whitey Sez:

"Trifles make perfection but perfection is no trifle . . . This grinding operation removes all foreign elements from the segmented wire, affording a positive bond with the flux coating to follow."

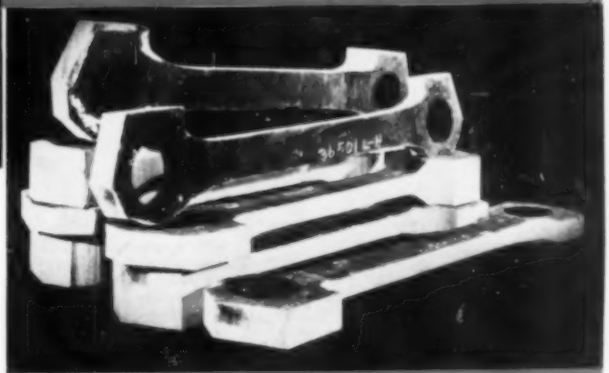
MAURATH, INC. BUILDER OF BETTER WELDING ELECTRODES IN ALL ANALYSES

CLEVELAND

FORGINGS *as specified—* 'PLUS'



+ TESTED STEELS



+ SUPERIOR Processing

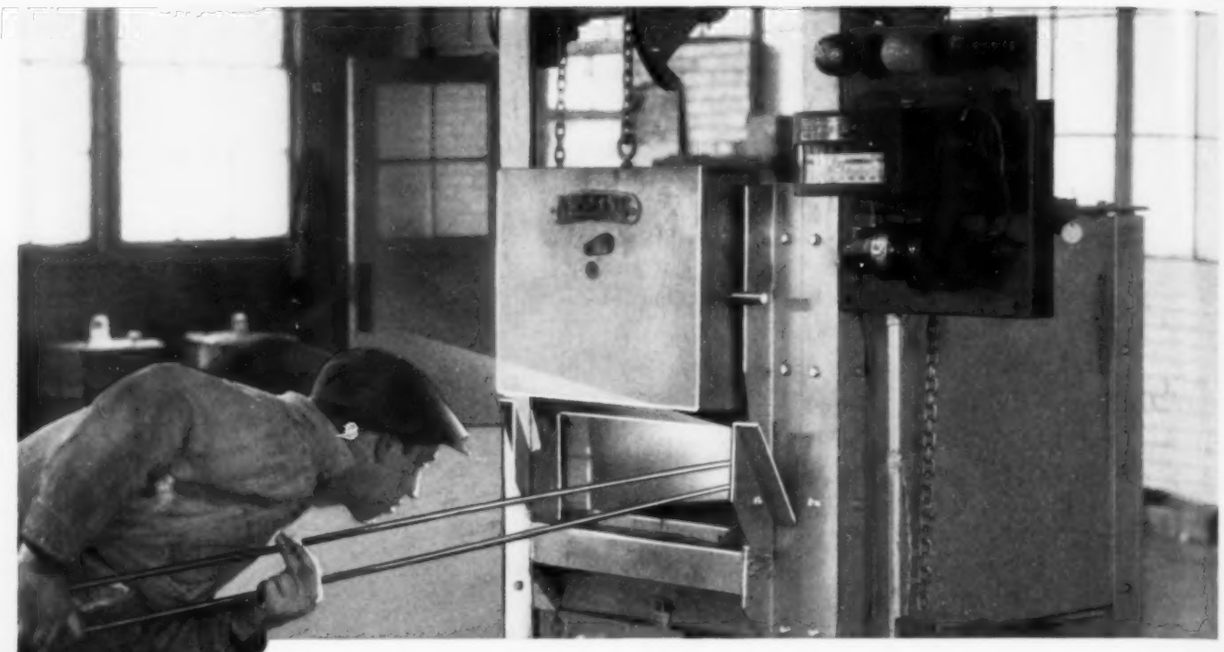
WE feel that merely meeting your specifications is not enough. It's the "hidden" values that the usual test pieces do NOT indicate that are much more important—values we develop through the use of tested steels . . . careful heating and forging . . . slow cooling, exact and thorough heat-treating. In short, tested steels and superior processing account for the HIGH QUALITY and LONG SERVICE for which Finkl Forgings are noted.

- We invite your inquiries for rough or finished, Alloy and Carbon steel forgings — particularly for those in which extreme DURABILITY is required.

A. FINKL & SONS CO.

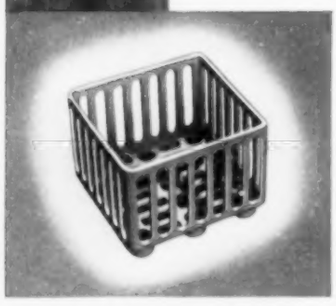
CHICAGO • ILLINOIS

CANADIAN LICENSEES:
Atlas Steels, Limited
Welland, Ont.



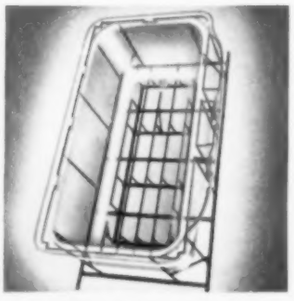
WHAT'LL YOU HAVE?

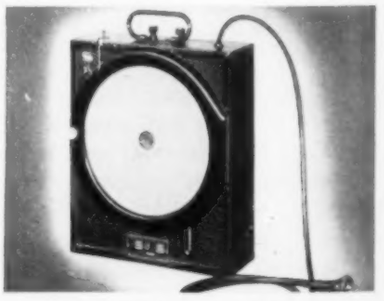
Well, you'll have good heat-treatment, if you use Hoskins Electric Furnaces. The one shown above is used by the Universal Cyclops Steel Company for drawing high-speed and hardening carbon steel tools. . . . We make electric box type and pot furnaces in several sizes, one of which will handle well your "fussiest" heat-treat job. Send for Catalog-56, describing them.



This is an Alloy 502 batch-type carburizing basket. For literature on our alloy castings, ask for "Every Shape and Form."

(Right) An enameling fixture designed by us for the bath-tub made by Briggs. We offer a personalized engineering service on design of castings, or on any problem you have, related to the things we make. You are invited to write to us.





An electric Recording Pyrometer, that is also portable, is often very handy to have around. This one, calibrated for Chromel couples, is described in Catalog 56.

(Below) Showing part of a battery of carbon combustion furnaces in the laboratory of The Ford Motor Company.

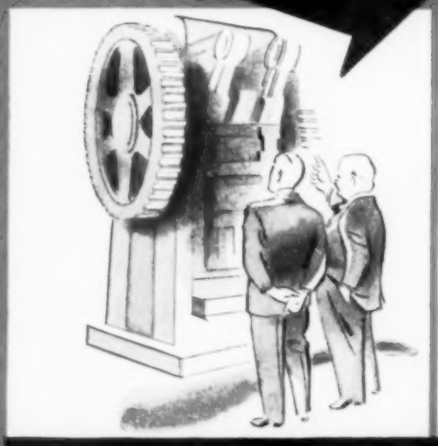
Chromel HEATING ELEMENT WIRE

HOSKINS PRODUCTS

ELECTRIC HEAT TREATING FURNACES • • HEATING ELEMENT ALLOYS • • THERMOCOUPLE AND LEAD WIRE • • PYROMETERS • • WELDING WIRE • • HEAT RESISTANT CASTINGS • • ENAMELING FIXTURES • • SPARK PLUG ELECTRODE WIRE • • SPECIAL ALLOYS OF NICKEL • • PROTECTION TUBES

HOSKINS MANUFACTURING COMPANY, DETROIT, MICHIGAN

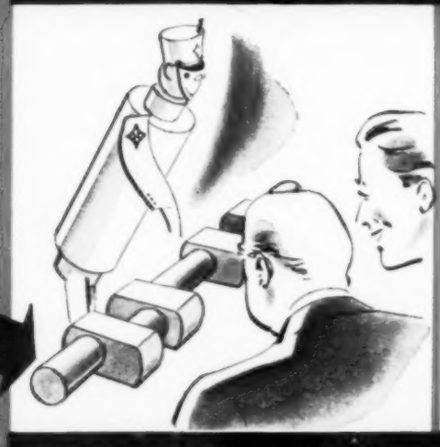
"SUPER" FORGING PUTS NEW LIFE IN A PRESS



"CRANK BREAKAGE ON THIS PRESS IS AVERAGING ONCE A WEEK . . .

"WE'RE WAY BEHIND SCHEDULE . . . WHAT CAN WE DO ABOUT IT?"

"'SUPER' FORGING REPORTING, GENTLEMEN . . . I'VE GOT THE ANSWER."



"THIS HEPPENSTALL CRANK (2-C-30 ALLOY) CAN TAKE THE RAP."

(Later) "YOU'RE RIGHT, 'SUPER'... TWO YEARS... AND STILL GOING!"

AT YOUR SERVICE . . .
These Aids To Industry.

You, too, may have some problem like this one . . . an actual instance from the service files of Heppenstall. Heppenstall forgings, die-blocks, or shear knives may help you to solve it. These products *start* with finer steel . . . produced in a modern plant, and backed by three generations of active experience. The service-life reflects the extra care and skill behind each operation.

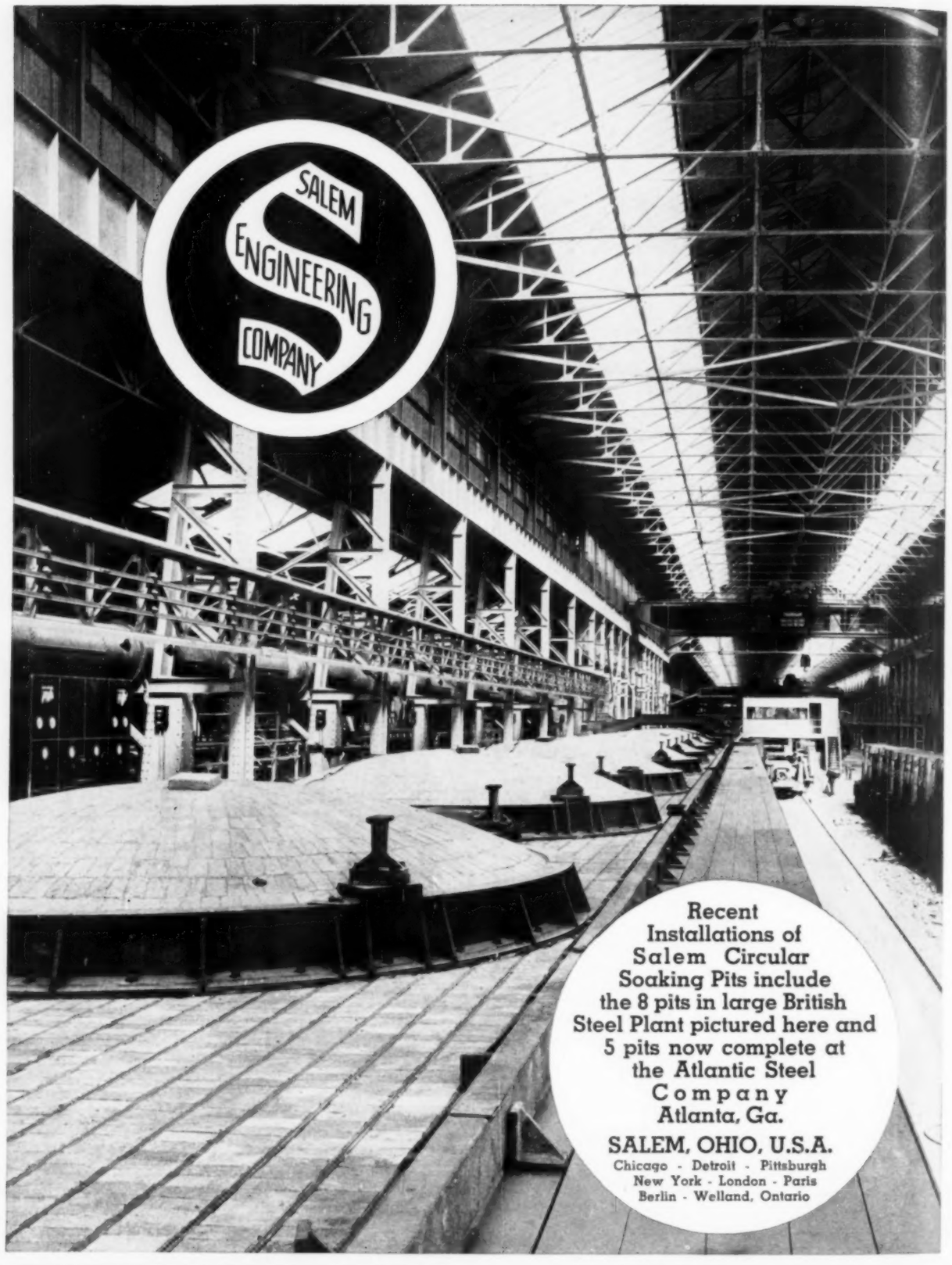
HEPPENSTALL PRODUCTS . . .

Die Blocks . . . Shear Knives . . . Hammer Rams . . . Piston Rods . . . Tinning and Galvanizing Rolls . . . Gellert Tongs . . . Locomotive Axles, Pins and Rods . . . E.I.S. and O.H. Alloy Steels . . . Carbon and Alloy Forgings.

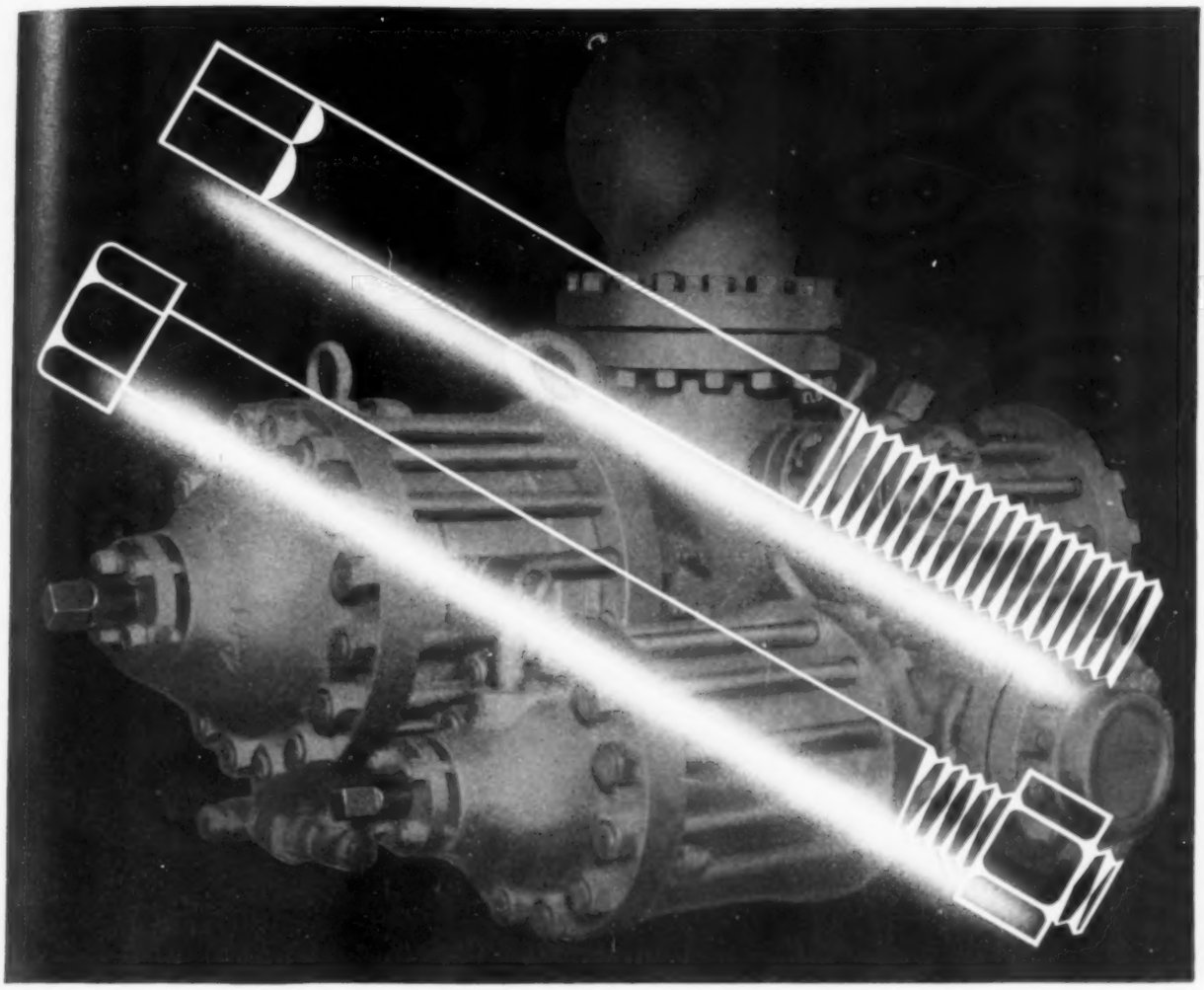
HEPPENSTALL — H — Heppenstall has the Experience — QUALITY

HEPPENSTALL COMPANY

PITTSBURGH · BRIDGEPORT · DETROIT



SALEM ENGINEERING COMPANY



WHERE HIGH PRESSURE MUST BE CONTROLLED

When oil drilling encounters pressures of several thousand pounds per square inch, there must be no "ifs" or "buts" about the blow-out preventer's capacity to hold things in check. In one particular type of blow-out preventer (6000-pound test), thrust screw and head bolts play a vital part in preventing accidents and waste. They are made of Chrome-Moly (S.A.E. 4140) steel because:

(a) Chrome-Moly bolt stock can be heat treated in tonnage lots with perfect assurance of consistently developing the combined strength and toughness to withstand heavy loads and to prevent threads from stripping.

(b) Chrome-Moly bolts are readily machinable after heat treating.

Bolt and parts manufacturers seeking to speed up and simplify production, reduce costs, and still give their customers a better product, should send for our free book, ***"Molybdenum in Steel."*** Climax Molybdenum Company, 500 Fifth Avenue, New York.

PRODUCERS OF FERRO-MOLYBDENUM, CALCIUM MOLYBDATE AND MOLYBDENUM TRIOXIDE

Climax Mo-lyb-den-um Company

MOLY

GRASSELLI CHEMICALS

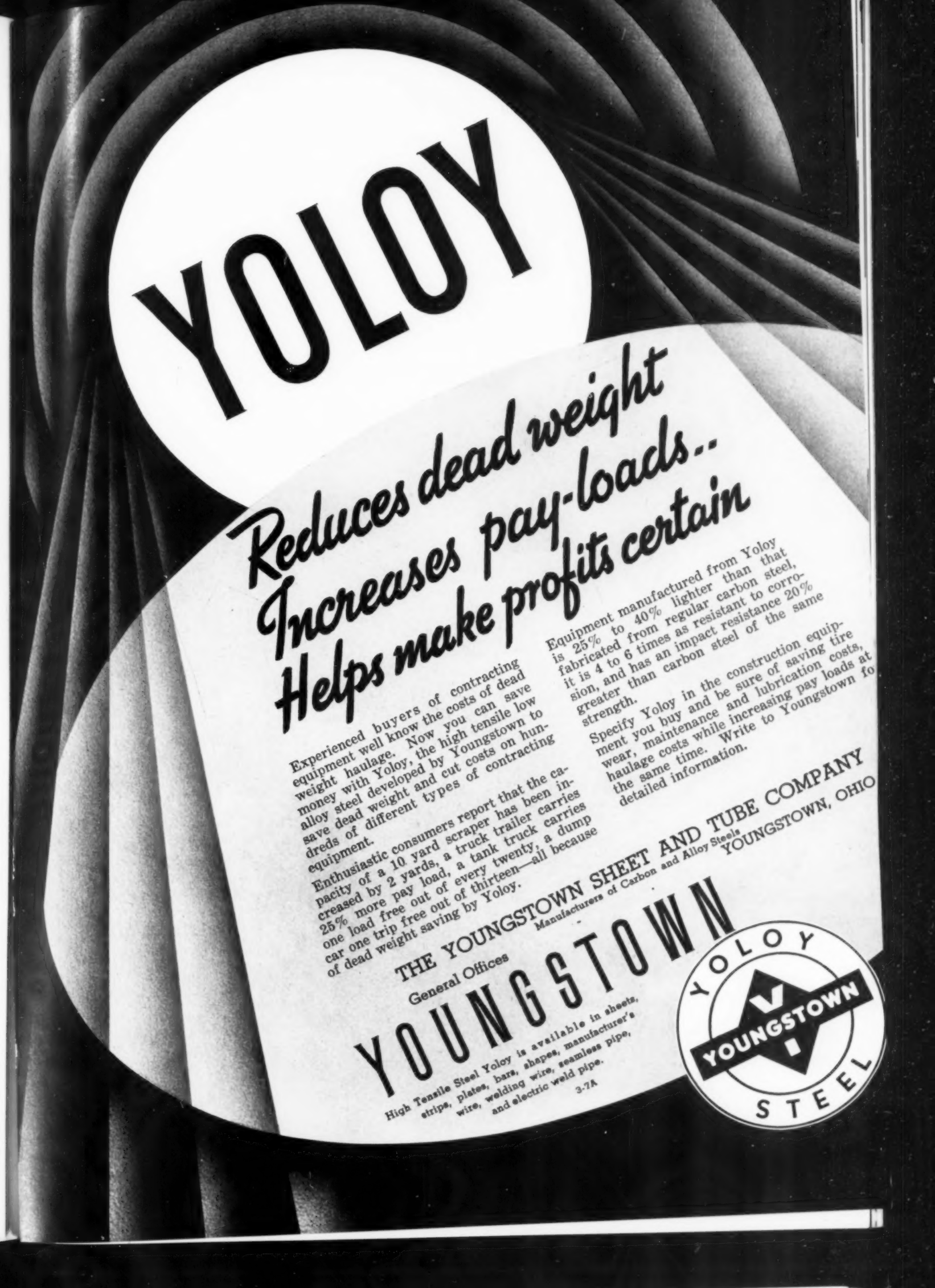
ACIDS • FLUXES • INHIBITORS • CLEANERS

• GRASSELLI Sulfuric Acid was first produced in strength suitable for early manufacture of iron and steel. Today it is available in all grades and strengths at points convenient to industrial centers. • As with Sulfuric Acid, GRASSELLI Fluxes, Inhibitors, Cleaning Chemicals and other Acids were developed to meet the needs of producers of iron and steel and its products. Technical service is available to assist in the use of GRASSELLI Chemicals.

SALES OFFICES: Birmingham • Boston • Charlotte • Chicago • Cincinnati • Cleveland • Detroit • Los Angeles • Milwaukee
New Haven • New Orleans • New York • Philadelphia • Pittsburgh • Rensselaer • San Francisco • St. Louis • St. Paul

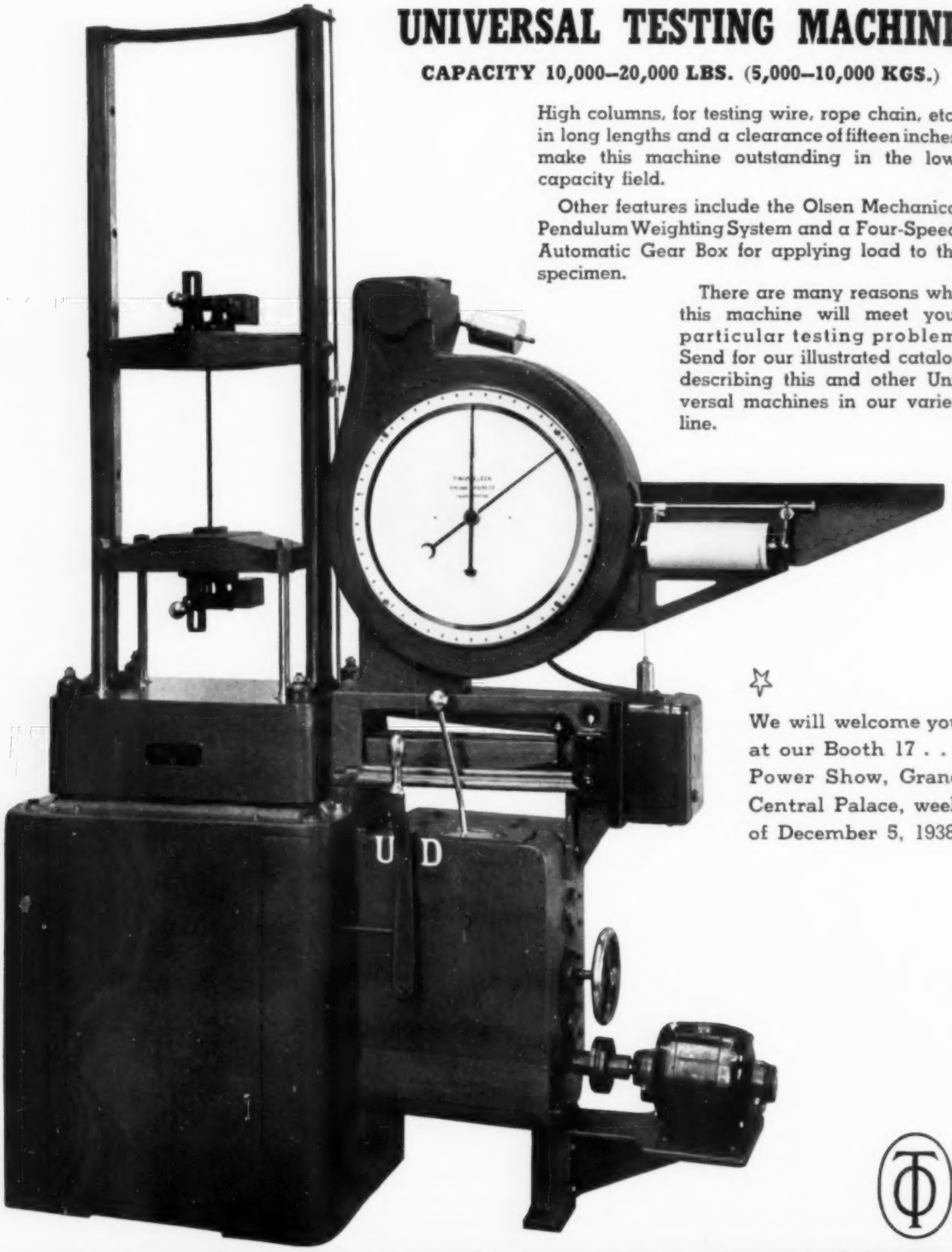
DU PONT
REG. U. S. PAT. OFF.

E. I. DU PONT DE NEMOURS & COMPANY, INC.


YOLOY
Reduces dead weight
Increases pay-loads..
Helps make profits certain
Experienced buyers of contracting equipment well know the costs of dead weight haulage. Now you can save money with Yoloy, the high tensile low alloy steel developed by Youngstown to save dead weight and cut costs on hundreds of different types of contracting equipment.
Enthusiastic consumers report that the capacity of a 10 yard scraper has been increased by 2 yards, a truck trailer carries 25% more pay load, a tank truck carries one load free out of every twenty, a dump car one trip free out of thirteen—all because of dead weight saving by Yoloy.
Equipment manufactured from Yoloy is 25% to 40% lighter than that fabricated from regular carbon steel, it is 4 to 6 times as resistant to corrosion, and has an impact resistance 20% greater than carbon steel of the same strength.
Specify Yoloy in the construction equipment you buy and be sure of saving tire wear, maintenance and lubrication costs, haulage costs while increasing pay loads at the same time. Write to Youngstown for detailed information.
THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices
YOUNGSTOWN, OHIO
YOUNGSTOWN
High Tensile Steel Yoloy is available in sheets, strips, plates, bars, shapes, manufacturer's wire, welding wire, seamless pipe, and electric weld pipe.
3-7A
YOLOY
YOUNGSTOWN
STEEL

UNIVERSAL TESTING MACHINE

CAPACITY 10,000–20,000 LBS. (5,000–10,000 KGS.)



High columns, for testing wire, rope chain, etc., in long lengths and a clearance of fifteen inches, make this machine outstanding in the low-capacity field.

Other features include the Olsen Mechanical Pendulum Weighting System and a Four-Speed, Automatic Gear Box for applying load to the specimen.

There are many reasons why this machine will meet your particular testing problem. Send for our illustrated catalog describing this and other Universal machines in our varied line.

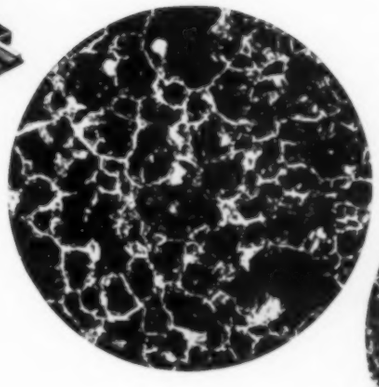
☆

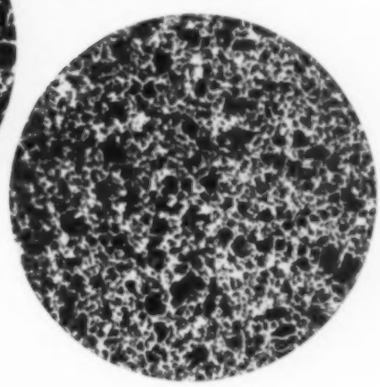
We will welcome you at our Booth 17 . . . Power Show, Grand Central Palace, week of December 5, 1938

TINIUS OLSEN TESTING MACHINE CO.

1202 BUTTONWOOD STREET, PHILADELPHIA, PA.

A word about GRAIN SIZE





These micrographs are of the same steel; specimen at left was normalized at 1825 deg. F.; specimen below was normalized at 1625 deg. F.

A precaution about specifying the McQuaid-Ehn Test

MANY users who heat-treat steel in their own plants find grain size important to their operations. Some prefer "coarse-grained" steel, with its deeper hardening characteristics in quenching and its somewhat better machinability. Others want "fine-grained" steel with its greater impact strength and toughness and its minimizing of distortion in heat treatment.

Coarse-grained and fine-grained. Since almost all types of steel can be made either coarse- or fine-grained, there has been a growing tendency to specify grain size by including in specifications the A. S. T. M. E19-33 carburizing test, also known as the McQuaid-Ehn Test.

The McQuaid-Ehn Test was developed sixteen years ago as a method of classifying carburizing steels, though today its use is by no means restricted to these grades. It is based on a microscopic examination of a sample which has been carburized at 1700 deg. F. and then slowly cooled. That the test is reliable for carburizing and other treatments around this temperature has long been established.

A warning. However, most authorities now agree that no steel should be classified as "fine-grained" or "coarse-grained" without first taking into consideration the temperature at which it will be heat treated. For example, a "coarse-grained" steel, as classified by the McQuaid-Ehn Test, would be coarse-grained when treated at 1700 deg. F.; it might be coarse-grained when quenched from 1600 deg. F., or it might be fine-grained. The McQuaid-Ehn Test will not show this—consequently this test should not be used indiscriminately in specifying grain size for all heat-treating operations.

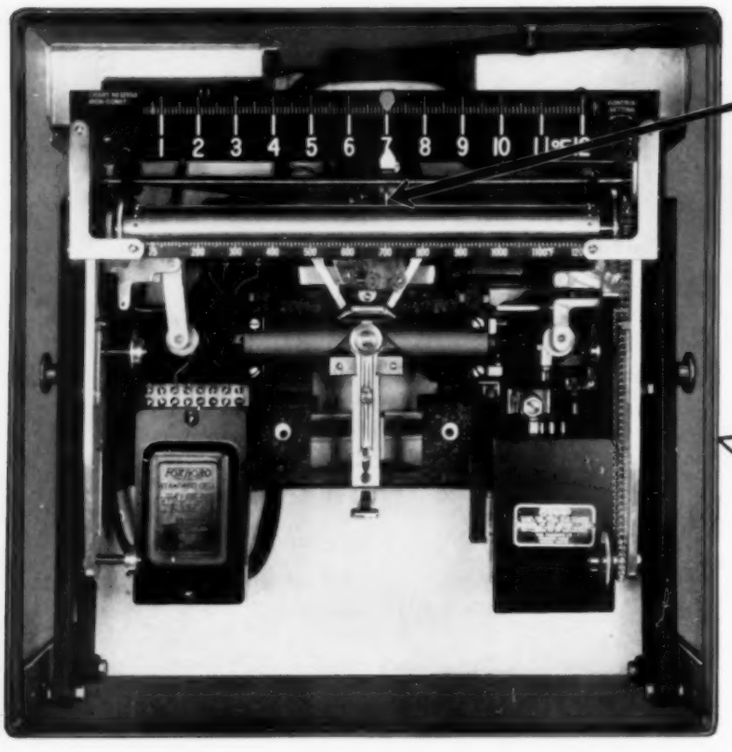
If this is important in your operations, we suggest you discuss it with a Bethlehem metallurgist. He can advise if the A. S. T. M. E19-33 test is what you should specify or if, instead, another method of testing will better fit your problem. There is no obligation on your part for this.

A paper entitled "Which Grain Size" appeared in the March, 1937, Transactions of the A.S.M. If you would like a reprint of this, write Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

Three move as One



FOR
UNIFIED ACCURACY
OF
INDICATION
RECORD
CONTROL

Slide-wire contact, recording pen, and control actuating mechanism—the three are one integral unit; their physical relation is fixed in the new Foxboro Recording-Controlling Pyrometer. They move as one . . . always! There are no linkages, belts or gears between them to cause inaccuracies. The slightest change in measurement produces a corresponding movement of record and control system. This is one of the exclusive Foxboro advantages that assures efficient and accurate operation. » » » A mechanically simple, dependable and sensitive mechanism operates the control contacts. An entirely original and unique automatic balancing mechanism is used. Contact construction provides a flexibility that makes possible the operation of regulating apparatus and signals, or different phases of regulation through separate circuits in one instrument. » » » Learn of the many outstanding features and the unexcelled performance of this new Foxboro Instrument. Write for Bulletin 765.

THE FOXBORO COMPANY
52 Neponset Avenue, Foxboro, Mass., U.S.A.
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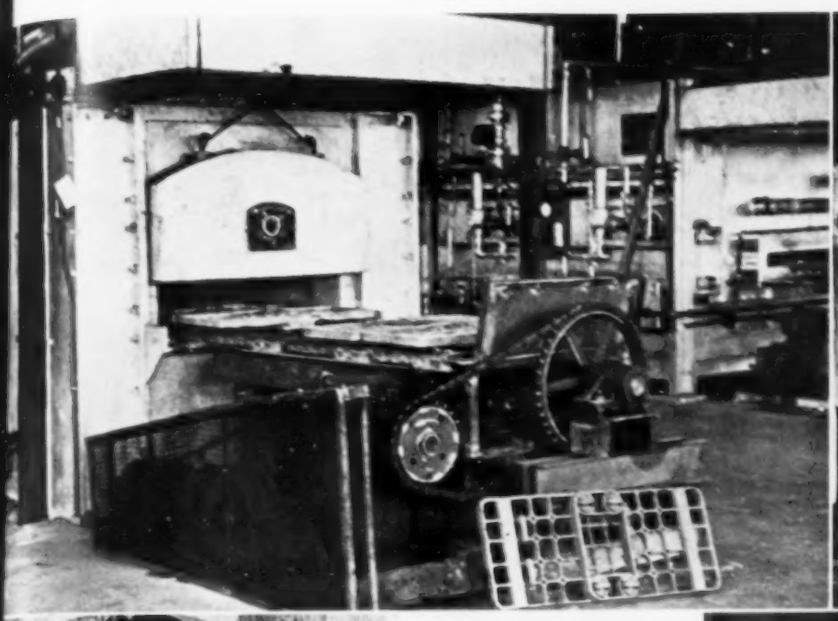
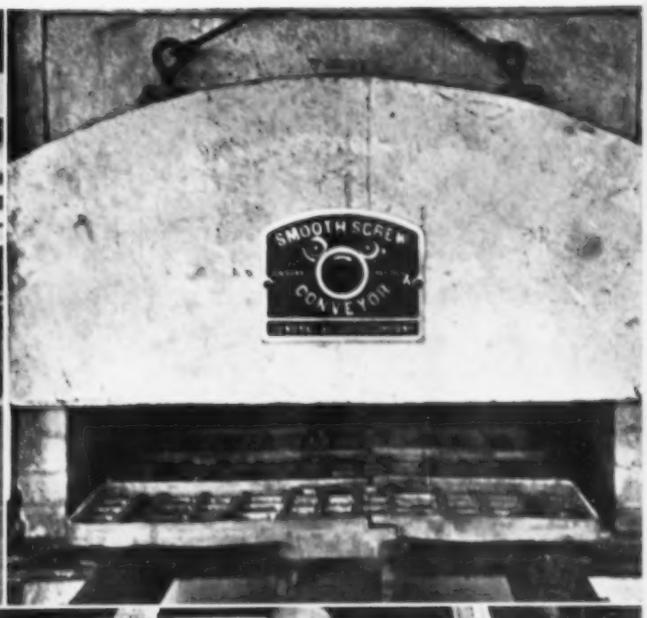
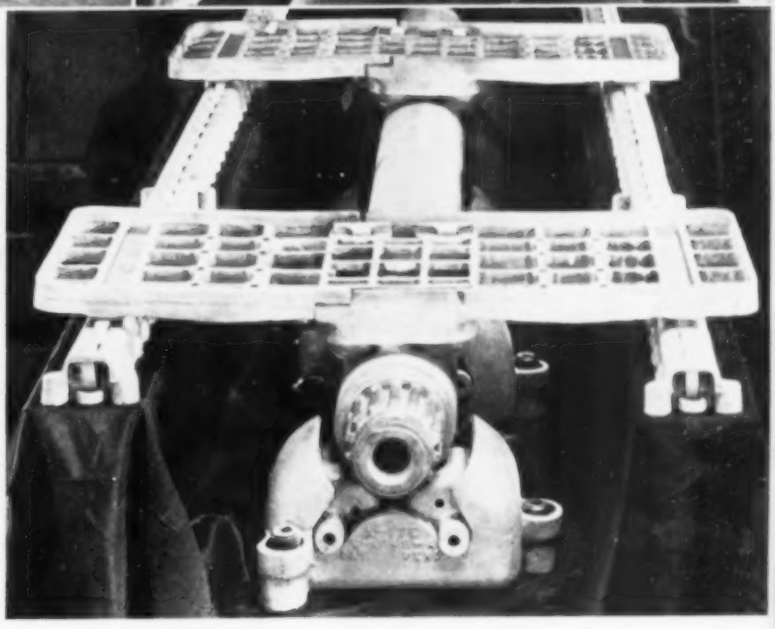
Engineered Alloys

METALLURGICALLY-MECHANICALLY





Smooth Screw
H. H. H.
PAT. PEND.
Installation
at
Warner Automotive Parts
AUBURN, IND.
LENGTH 44 FEET



MOOTH SCREW Conveyor is designed as a high tempera- ture mechanism. It is inherently "full floating." At no nt does it depend upon accurate registration of the mech- sm with the charge or any mechanical components. The re is simple, rotary, uni-directional with no reversal of sses, and speed is easily controlled thru standard variable ed drives. All friction is on time-honored "grindstone" rings similar to General Alloys roller rails in service 18 rs. All loads and frictions are below those in common use. ling friction bearings are available for high loads.

bearings, rollers, muffle rails, etc., are easily *replaceable* d *adjustable* as to alignment.

e movement is the simple principle of angulating rolls on wheels of a small carriage on a rotating cylinder. The raw bar" pull (excess tractive force over that necessary to move empty or loaded tray) of an empty tray is 8 lbs. and of a loaded tray 20 lbs. No chance for damage to alloy in case of a jam because rolling friction provides *automatic, positive* safety.

SMOOTH SCREW

1. Permits the use of lighter trays.
2. Insures longer life trays because ramrod effect of pusher trays eliminated and
3. Eliminates expansion of trays against full furnace load.
4. Permits intermittent charging and reduced capacity operation without loss of efficiency.
5. Maximum flexibility of time cycle with minimum lost time and waste heat.
6. Conserves heat—no dummy load when charging and discharging.
7. Fully reversible—can be charged and discharged from same end.
8. Fully guaranteed by oldest and largest exclusive manufacturer heat resistant castings.

GENERAL ALLOYS COMPANY, BOSTON, MASS.

BRANCHES IN TWENTY PRINCIPAL CITIES

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AMERICAN Radials have an enviable reputation for long productive life and precision performance. Engineers of the American Tool Works Company, builders of American Radials, specify Ampco Metal for elevating nuts, because only Ampco Metal provides the qualities of wear resistance and long life required to protect the vital elevating mechanism of these tools.

Ampco Metal is the invariable choice of machine tool builders for extreme service parts where resistance to wear and maintained accuracy are essential.

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Pots lasted TWICE our Guarantee

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"Design and Selection of Alloys for Heat Treating Furnaces" and "Calite Pots, Boxes & Retorts"

THE CALORIZING CO.

Largest Manufacturers High Temperature Metals

Note: This statement includes Colorized Steel—as well as Cr-Ni Alloys

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To Those - - -

who have straight carbon tool steel applications, *Vulcan K-R* steel treats like a carbon steel, yet is deep hardening, has a higher surface hardness and holds up well under shock.

The few cents difference in price will mean more to you in added production, due to greater wear resistance.

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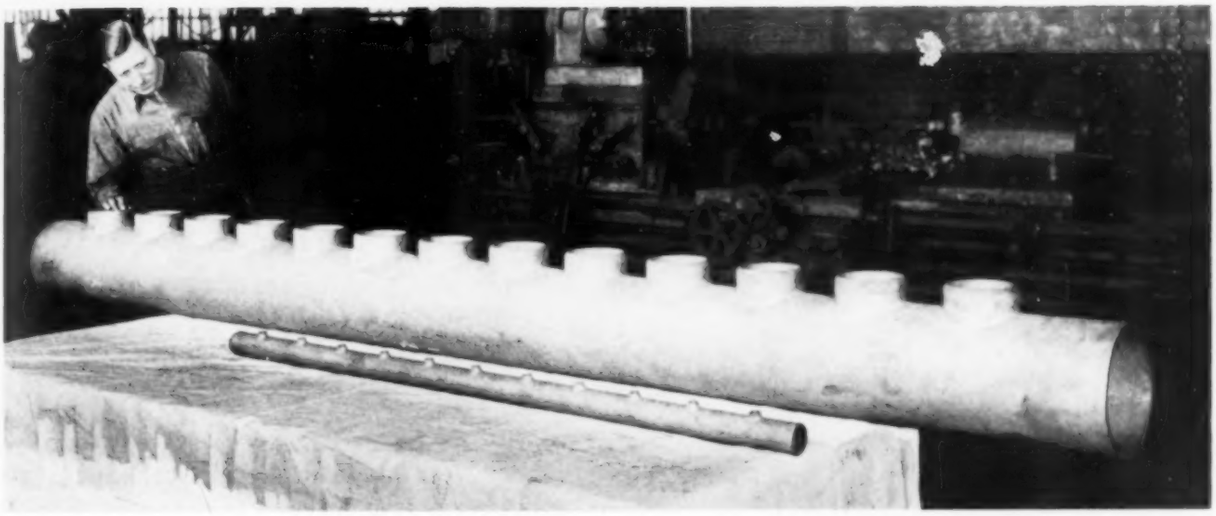
MISCO "Centricast"*

(CENTRIFUGALLY CAST)

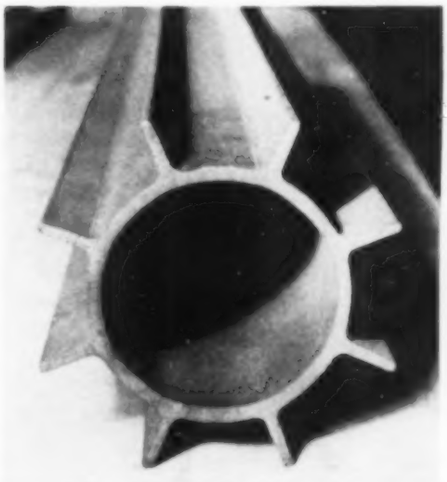
Headers · Manifolds · Radiant Tubes



10" I. D. x 3/8" thick x 10' - 0" long Misco "Centricast" Header. 6" radial outlets chamfered for welding.

**Trade Name Registered*

CENTRIFUGAL castings produced by Misco include Headers, Manifolds, Radiant Heater Tubes, and many other unusual shapes. Equipment manufacturers specify Misco for all tubular castings because centrifugal castings produced by Misco are accurate and sound. Misco also produces better sand castings in stationary molds. More than 2000 progressive companies use Misco centrifugal and stationary sand castings.



4" I. D. x 1/4" thick Misco "Centricast" Radiant Heater Tube

Member Alloy Casting Research Institute

MICHIGAN STEEL CASTING COMPANY

One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castings

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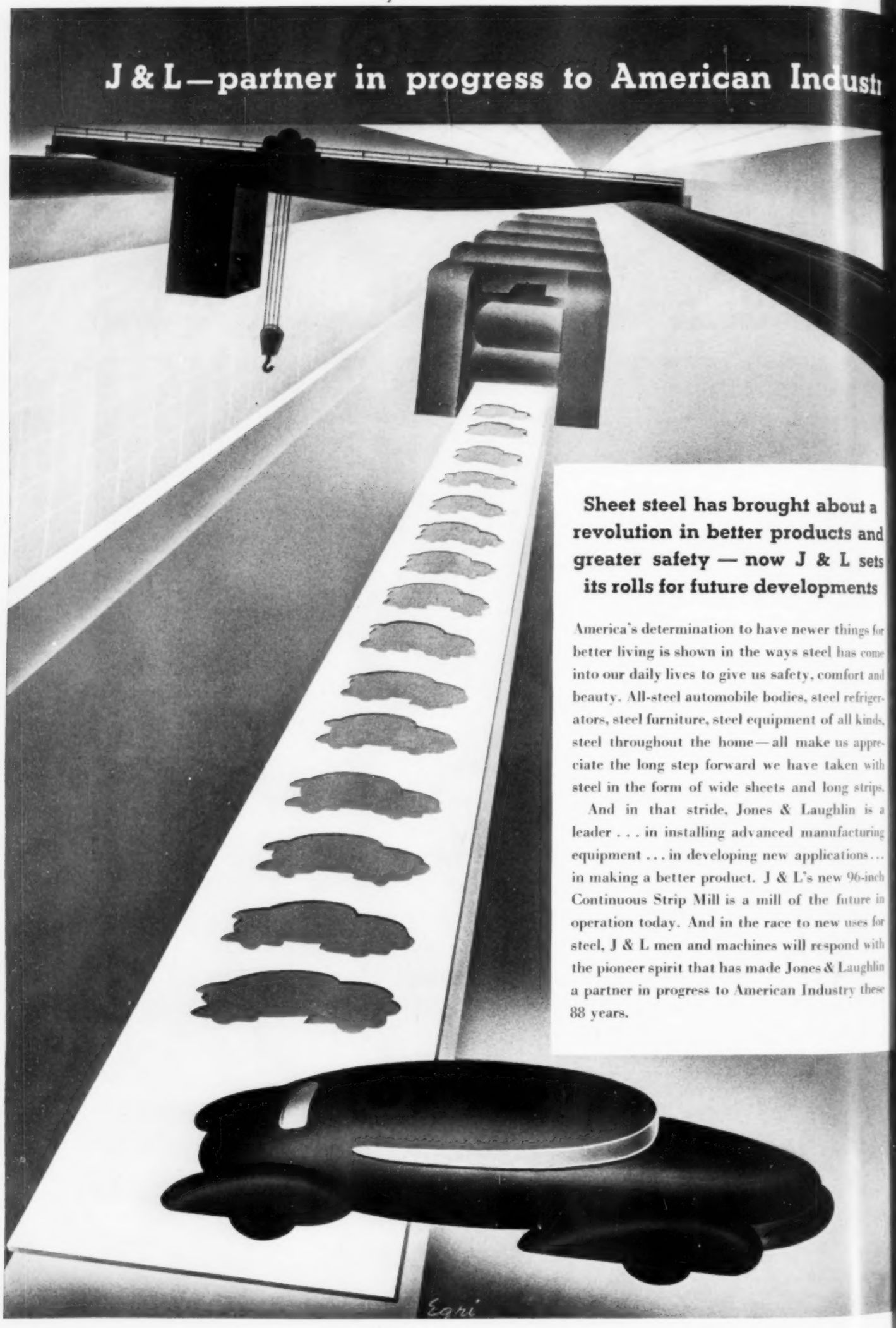
Heat and Corrosion Resistant Alloys

J & L—partner in progress to American Industr



Sheet steel has brought about a revolution in better products and greater safety — now J & L sets its rolls for future developments

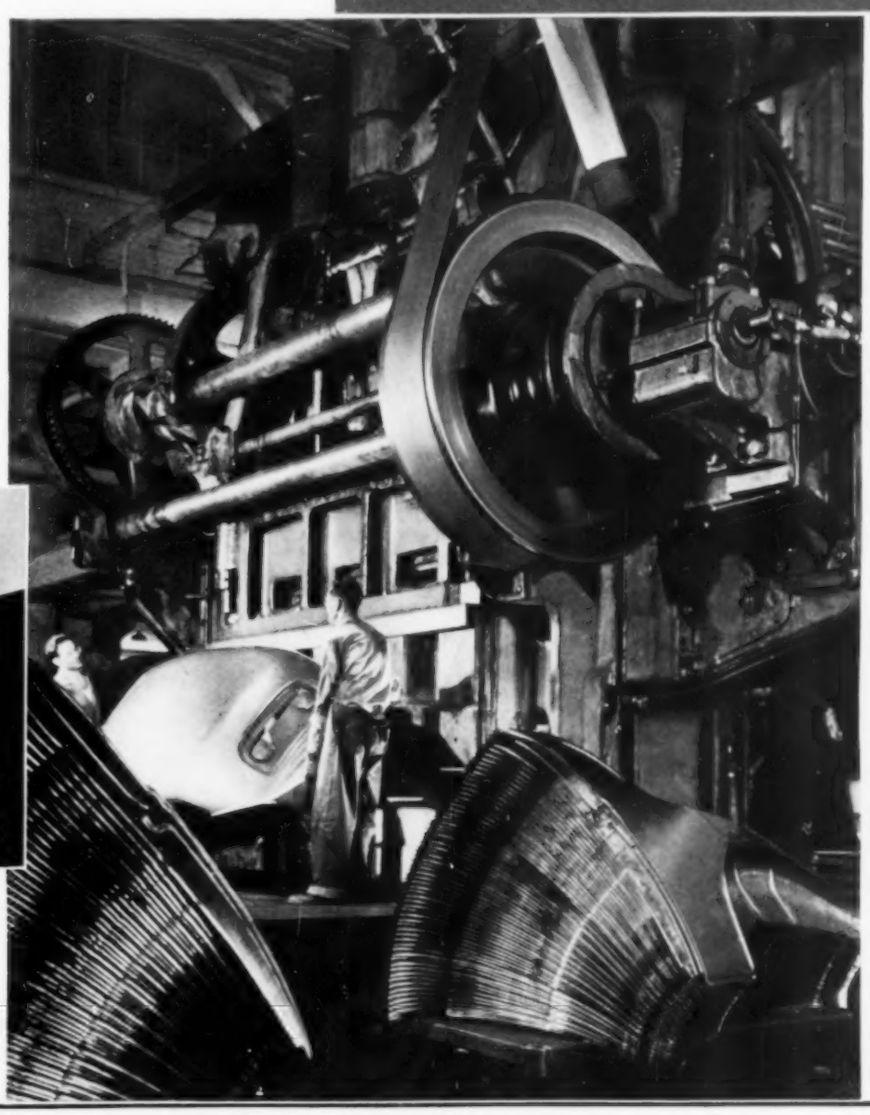
America's determination to have newer things for better living is shown in the ways steel has come into our daily lives to give us safety, comfort and beauty. All-steel automobile bodies, steel refrigerators, steel furniture, steel equipment of all kinds, steel throughout the home—all make us appreciate the long step forward we have taken with steel in the form of wide sheets and long strips.

And in that stride, Jones & Laughlin is a leader . . . in installing advanced manufacturing equipment . . . in developing new applications . . . in making a better product. J & L's new 96-inch Continuous Strip Mill is a mill of the future in operation today. And in the race to new uses for steel, J & L men and machines will respond with the pioneer spirit that has made Jones & Laughlin a partner in progress to American Industry these 88 years.

J & L—partner in progress to American Industry

J&L STEEL

This illustration, taken in a large, modern stamping plant, shows one of the gigantic presses forming of J & L cold rolled sheets, complete side panels and one-piece tops for a new model automobile.



J & L—ALWAYS MAKING FINER STEELS FOR NEW AND BETTER USES

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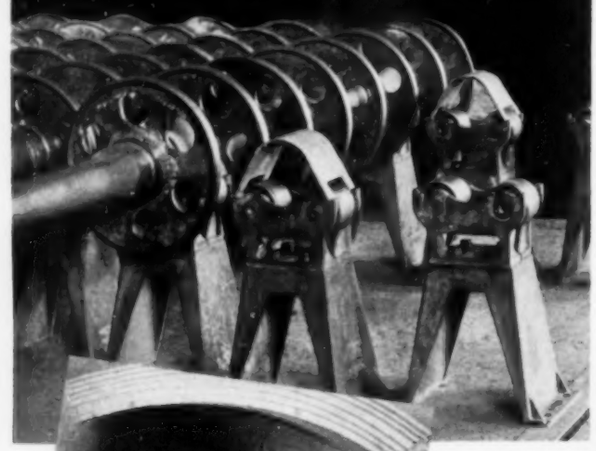
AMERICAN IRON AND STEEL WORKS

PITTSBURGH, PENNSYLVANIA

MAKERS OF HIGH QUALITY IRON AND STEEL PRODUCTS SINCE 1850

High-Temperature *Conveyors*



Cast in any one of the standard Driver-Harris alloys to suit the specific operating conditions.

Saving in first cost of alloy from 25 to 35%

On wide furnace, saving in alloy over 35%

● Operating at heat-treating temperatures, these furnace roller shafts and bearings, designed particularly for normalizing, save fuel, alloy expense and eliminate cooling water. Lower in first cost than either outside bearing shafts or walking beams. Lower cost per ton of steel produced.

Seven huge furnaces now in operation with such equipment. One has turned out over 70,000 net tons of sheet and strip at exceptionally low cost for alloy and fuel.

May we submit facts and figures? Meanwhile, don't hesitate to submit your high-temperature conveyor problems for engineering aid.

DRIVER-HARRIS COMPANY
HARRISON, N. J.

Chicago Detroit Cleveland — England - France Italy

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NICHROME

Columbia TOOL STEEL

As the year end draws near, we want to express our appreciation for the confidence and loyalty of the A.S.M. group as shown by their preference for Columbia Tool Steel.

To all, we hope we have merited your valued patronage.

It pays to use Good Tool Steel

COLUMBIA TOOL STEEL COMPANY
MAIN OFFICE AND WORKS
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SPECIMEN POLISHING AT L-O-W SPEEDS . . .

AB

●Recent findings in research bring to view specific advantages in polishing metallographic specimens at low speeds. The A-B Low Speed Polisher shown above meets the requirements of those who want these advantages in this phase of specimen preparation. It is a highly efficient and sturdily built equipment and embodies desirable use-conveniences.

The 1938 "METAL ANALYST" having many NEW items is in preparation. Shall we reserve a copy for you?

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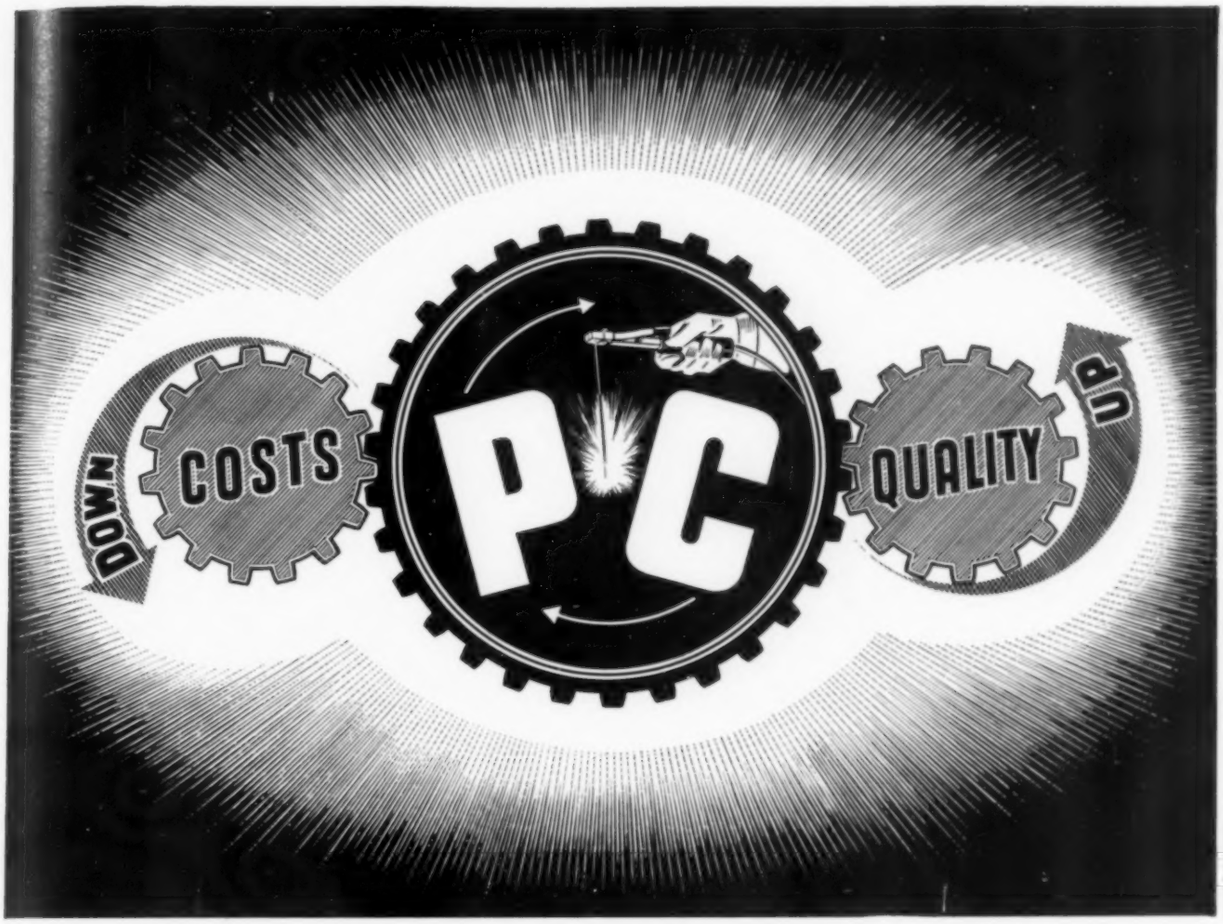

AN OPERATION FOR EXECUTIVE ATTENTION

for lower costs · · · for higher quality · · · for profits

• When the wheels of business slow down, every executive has a driving urge to *do* something about it. Here's a plan to convert that urge into *results*... more jobs for workmen ... more earnings ... more service value ... *more profit for everybody.*

Start a *crusade for profits.*

As the first step, appoint from your organization a PROFIT CRUSADER. Such a man will make arc welding the spearhead of his attack. He *knows* from experience that welded steel construction cuts costs and improves products. Fired with zeal and enthusiasm, he develops superior products that cost less to build, less to sell, less to operate and less to service. The PROFIT CRUSADER makes everybody's dollar go farther.

As the second step, give the PROFIT CRUSADER executive *authority* to get results. Mr. R. G. LeTourneau, Pres., R. G. LeTourneau, Inc., Peoria, Ill., is one of the executives who recommends this plan of operation. He says, "To exploit successfully the far-reaching advantages of welded steel construction, the manufacturer or builder should have in his organization a man of authority with a zest for using welding."

We can help you in this crusade for profits. Call on the nearest Lincoln office for counsel or have your secretary write for the book shown below. THE LINCOLN ELECTRIC CO., Dept. MM-544, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.

PROFIT CRUSADER—The man in your organization with a zest for cutting costs and improving products by means of welding. *Everybody profits.*

A book has been compiled giving valuable suggestions for the Profit Crusader. Write for your free copy of "How to Change Over to Welded Design for Profit."

THE LINCOLN ELECTRIC CO.
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FOR PUBLISHING ACHIEVEMENT
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for the greatest improvement in typography and format during the twelve months ending August 1, 1938 in the annual competition conducted by
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"A first award has been made for greatest improvement in typography during the past twelve months, but it is no detraction to the winner to put on record the fact that if the terms of the award had not been specifically for *improvement in the past twelve months*, first place rather than honorable mention would have gone without competition to Metal Progress, which has maintained a uniquely high standard of typographical excellence since its foundation eight years ago."—*Wm. E. McFee*, Director, Copy and Plans, American Rolling Mill Co., and member of the award committee, in presenting this plaque.

If you or your company sell the metal industry, write for the new booklet showing just how Metal Progress fits into your sales promotion picture.

METAL PROGRESS

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To Improve Quality

CRANE USES X-RAY IN RESEARCH

TO guide the development and control of improved casting techniques, and to point the way to better welding methods, the Crane Company has extended its use of x-ray. Progressive manufacturers are always seeking higher quality and lower costs, advantages that may be passed along to their customers—and Crane has found x-ray to be a most accurate method of non-destructive testing for research and development.

Radiographs not only show accurately the location and type of flaw which may be in a casting or weld, but in addition may be interpreted to learn techniques that will eliminate such imperfections from future production. And some users employ radiographs to guide the repair by welding of large expensive castings before any damage is done through use.

General Electric X-Ray equipment is used by the majority of those important concerns which employ x-ray, not only because of its reputation for reliable and economical performance, but also because there is a type of G-E X-Ray unit exactly suited to each kind of application. Crane's new apparatus is a 400,000-volt completely oil-immersed shockproof and climate-proof unit, designed to withstand the rigorous service expected of heavy industrial equipment. And like other G-E X-Ray installations, the unit is mounted to provide the flexibility, convenience of application, and simplicity of operation required by the particular job it is to do.

Take advantage of the services of experienced x-ray engineers by asking for their help in applying x-ray examination in your plant. And rest assured, they will be the first to tell you if x-ray, for some reason, won't do the job you have in mind. Address your inquiry to Dept. 1312. General Electric X-Ray Corporation, 2012 Jackson Blvd., Chicago, Illinois.

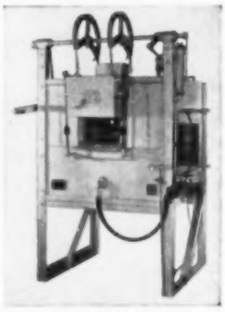
GENERAL ELECTRIC X-RAY CORPORATION
2012 JACKSON BOULEVARD CHICAGO, ILLINOIS

Metal Show visitors who came expressly to study the latest developments in atmosphere control, were outspoken in their opinion that "Certain Curtain" is more than ever the simplest and most practical - - in fact, the only successful system for general use.

They brought hundreds of samples to be hardened at our booth, and as a result of this work we have already received several orders, as well as a host of requests to quote.

We respectfully suggest that, whatever your controlled atmosphere heat treating needs, you investigate "Certain Curtain" furnaces. Recent improvements in "Certain Curtain" control, without change of basic principles, have greatly widened the scope of application.

Vertical Tool Furnace



Standard Tool Furnace

C. I. HAYES, INC.

Makers of Electric Furnaces — Est. 1905

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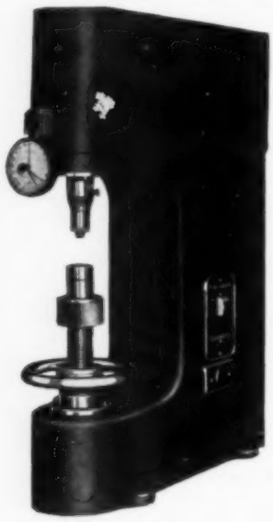
ELECTRIC CERTAIN CURTAIN FURNACES

REGISTERED U. S. PAT. OFFICE

KEEPING PACE WITH PRODUCTION

This modern instrument solves your hardness testing problem



Model "PR"

Capacity—
2600 tests per hour.

Accuracy—
Within standard test bar limits.

Tolerance—
In excess of .125" variation.

Loading—
Major and Minor, DEAD WEIGHT, fully automatic and CONSTANT; 60 Kg; 100 Kg; 150 Kg.

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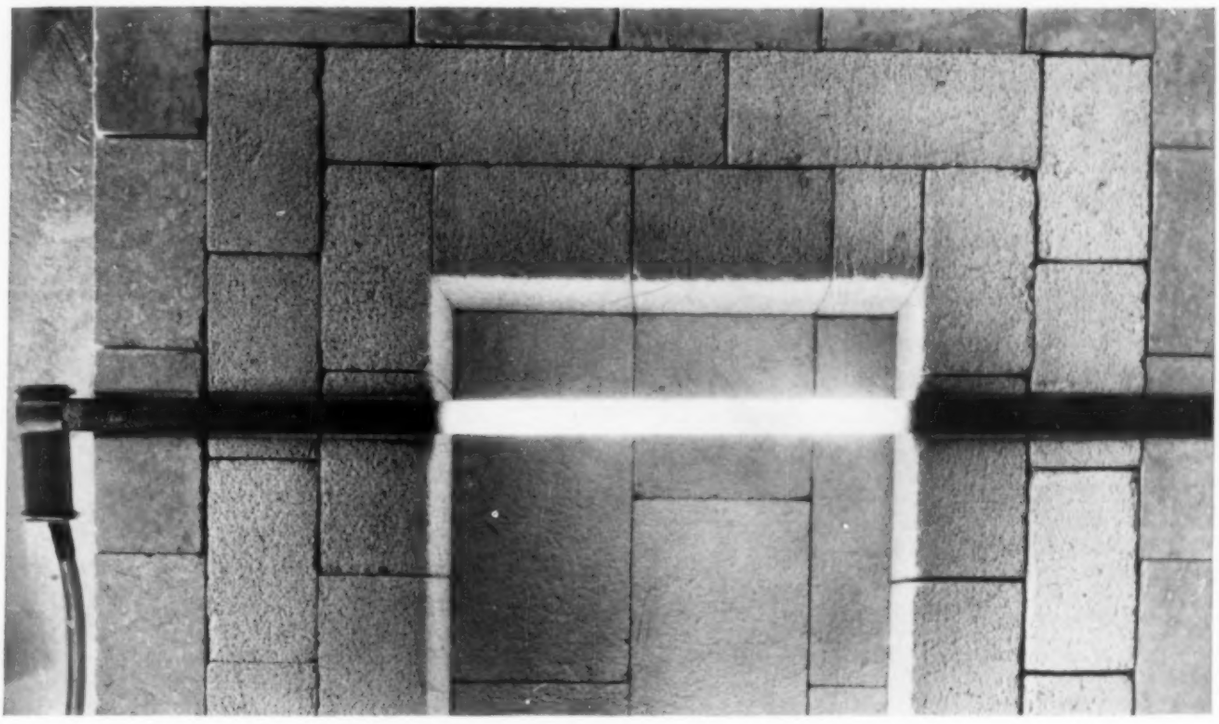
NEW GLOBAR "AT" TYPE ELECTRIC HEATING ELEMENTS *with integral terminals*

BRAND



New economy and reliability for users of small and medium sized furnaces

The new Globar Brand "AT" Type Electric Heating Elements bring many advantages to users of small and medium sized furnaces. The integral terminal construction of these elements means reduced heat losses, lower operating costs and reliability of performance. These new elements also reduce the cost of furnace construction because terminal mountings and accessories are not used. There are no gadgets to get out of order. The elements are easy to install, require no maintenance and give long and trouble-free service. These advantages add up to unusual economy and reliability in operation.

The success of Globar "AT" Type elements results from the fact that the terminals are integral with the heating section and are so constructed that they remain relatively cool. In fact the heating section and terminals form a continuous ceramic rod with a high resistance center and low resistance ends. These new elements quickly and quietly develop temperatures up to 2750° F. without fumes or dirt. They have been tested in the field and have established a proven record of performance.

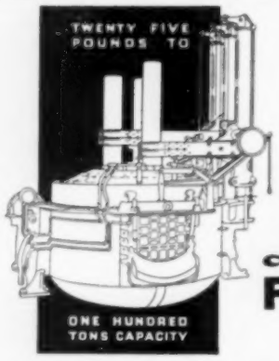
For heavy duty high temperature furnaces we recommend Globar Pin Type elements. They have separate terminals and terminal mountings but, like the "AT" Type elements, they do not require water cooling. Whatever type of furnace you operate there is a specific Globar element to meet your requirements. Give us full information on your heating problem and our experienced engineering department will gladly submit recommendations without cost or obligation.

GLOBAR DIVISION, THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

REG. U. S. PAT. OFF.

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

(Carborundum and Globar are registered trade-marks of The Carborundum Company)



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A heavy shell of pure carbon seals the energizing material in CHAR Carburizers in such manner that it cannot escape.

The result is a carburizer of longer life, lower dusting loss, and continuously uniform activity.

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CARBURIZERS

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Aircraft alloys

(Starts on page 670) resistance to corrosion was limited. It was true that some of the aluminum alloys displayed a remarkable resistance to corrosion even by sea water, but in the magnesium alloys that position had not yet been attained; therefore, it would seem that research should be directed mainly not to obtaining inherently resistant alloys but to the production of protective films of greater stability than those obtained by the ordinary methods.

H. Sutton remarked that while the aluminum-magnesium series of alloys had not been widely used in English aircraft, they had been used in considerable quantities for motor buses. Aircraft constructors were afraid of failure by stress corrosion. Nowadays there was a tendency for stresses to remain locked up in a structure and for failure to occur, not necessarily under working stresses due to the aircraft, but to the way in which it had been put together. It was important, therefore, to use materials which had considerable resistance to stress, even though the applied load on the members of the aircraft were reasonably small.

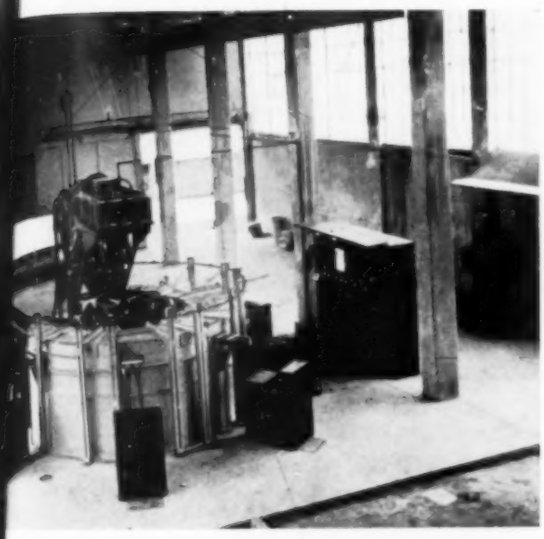
Replying to the discussion, M. le Coeuvre said that the aluminum-magnesium alloys are still being discussed very much in France from the point of view of corrosion and fatigue and also stress corrosion. Some of the alloys that had been tried had been frankly disappointing. In his view the solution of the stress corrosion and fatigue problem was to endeavor to arrange the chemical analysis and metallographical constituents of the metal so that if the protective film were broken at each reversal of stress, it would re-form very quickly.

[**Editor's Note:** The 7 to 9% magnesium-aluminum alloys have been vigorously promoted in Germany; American experience is that these alloys are more difficult to work, either hot or cold, than other aluminum alloys, equally strong, but low in magnesium. As pointed out by T. W. Bossert in **Metal Progress** for January 1937, American aircraft favor 17S and its improved variant 24S. Typical composition of 17S is 4% Cu, 0.5% Mn, and 0.5% Mg; 24S is 4.2% Cu, 0.5% Mn, and 1.5% Mg. In heat treated, quenched and aged condition 17S-T has the following typical properties: 58,000 psi. tensile strength, 35,000 psi. yield, 20% elongation in 2 in.; 24S-T has 65,000, 43,000 and 20 respectively. The strength of either can be increased by cold working, with corresponding loss in ductility. Corrosion resistance is achieved in the alclad form. About the highest alloy in magnesium which is now commercial in the United States is known as 56S (5¼% Mg, 0.1% Cr, 0.1% Mn), utilized almost exclusively as wire and wire products on account of its excellent performance in the drawing dies.]

ajax HULTGREN ELECTRIC SALT BATH FURNACE

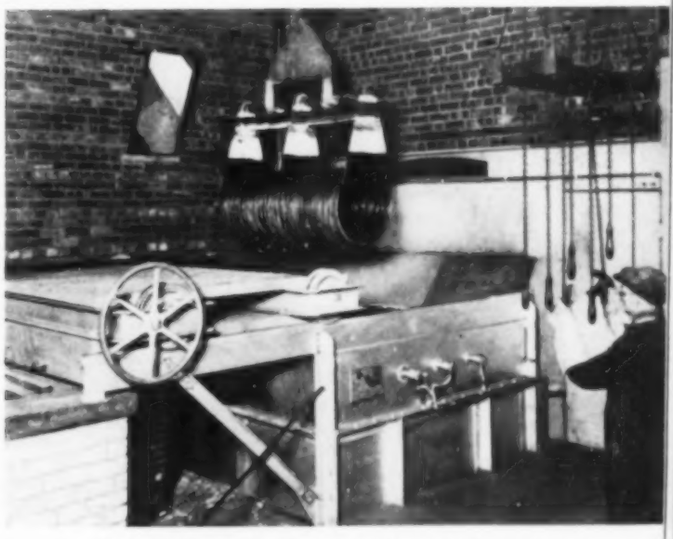
...st advanced carburizing practice—recent installation of ...x Hultgren Furnaces carburizing compressor parts for ...'s leading electric refrigerator.

ALL the advantages of salt bath hardening - - and NONE of the disadvantages!

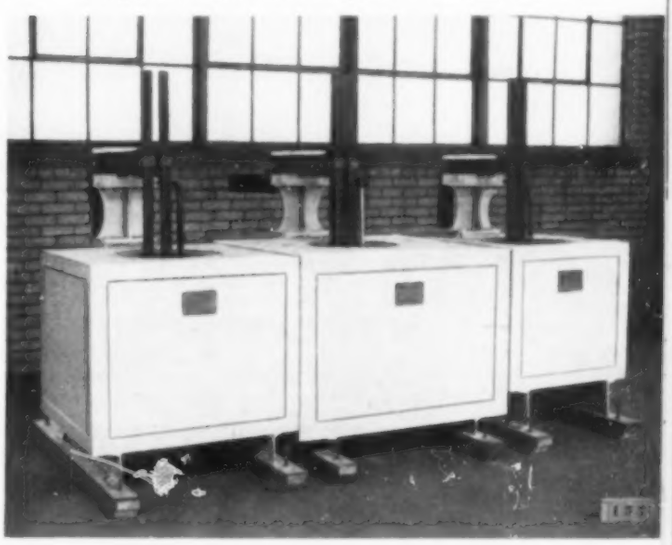


...r the first time, a completely mechanized salt bath furnace ...r hardening small parts such as screws, lock washers, chain ..., stampings, etc. Work is weighed, charged, passed through ...e hardening bath, quenched, washed and dried—all in auto... sequence.

Annealing steel wire—total heating cycle 15 minutes compared with 4 hours previously required.



Preheat, high heat and quench units for hardening carbon tool steels and 18-4-1, and molybdenum-tungsten high speed steel tools without decarburization or shrinkage. Sharp edges left intact. No "atmosphere" to contend with.



...attleships or household appliances, airplanes, or automobiles .... in heat treating the vital parts of all products, Ajax-Hultgren Furnaces are improving production in plants all over ...e country and earning their own cost many times over with ...eir economical operation.

The patented internal heating principle, coupled with the ...utomatic stirring action of the bath, assures absolute tempera...re uniformity throughout the entire heat treating range—...om 300 F. to 2400 F. Think of what this means on pot cost ...lone! Users have reported savings as high as 95% on this one ...eature.

A savings in heating cost of as much as 50% is possible ...ecause immersed electrodes generate heat in the most eco...omical manner.

If you must have maximum uniformity in your heat treating, let us show you how the Ajax-Hultgren Salt Bath Furnace ...an give it to you—plus a sizeable reduction in heat treating ...osts.

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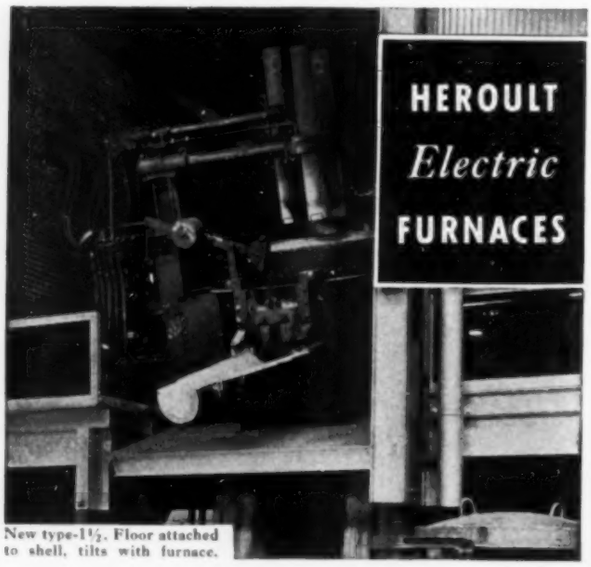

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Recuperators

Results obtained with Carborundum Company's recuperators using Carbofrax tubes are fuel savings, closer temperature control, faster heating, and improved furnace atmosphere. Complete engineering data are given in Bulletin Fx-57.

Cutting Steel

Recommended practices for gas cutting of structural steel are given in a concise and authoritative form by Linde Air Products Co. Qualification tests for good workmanship from the standpoint of accuracy and smoothness of cuts are also described. Bulletin Dc-63.

Cr-Ni-Mo Steels

A. Finkl & Sons' new catalog is really a technical treatise on chromium-nickel-molybdenum steels for forgings. Pocket size, 104 pages, cloth bound, illustrated by photographs, charts and tables. Bulletin La-23.

Pure Metals

Pure, carbide-free metals are described and applications suggested in a pamphlet published by Metal & Thermit Corp., who make pure tungsten, chromium and manganese in addition to the ferro-alloys. Bulletin Ma-64.

Electroplating

A complete group of chemicals, processes and materials of interest to those engaged in electroplating is listed in this 8-page booklet published by the E. I. Du Pont de Nemours & Co., Inc. Bulletin Eb-29.

Seamless Tubes

Just prepared by the Timken Steel and Tube Division of Timken Roller Bearing Co. is a "Guide for Users of High Temperature Steels," which presents technical data relating to the various properties of Timken seamless tubes. Bulletin Bb-71.

Stainless Data Book

All users of stainless and heat resisting alloys should find invaluable the information contained in a booklet published by Maurath, Inc., giving complete analyses of the alloys produced by the different manufacturers, along with the proper electrodes for welding each of them. Bulletin Jy-125.

Moly in Steel

Metallurgists, engineers and production executives who are really interested in the metallurgy of steels and their application will want the newly published book on molybdenum steels which has just been released by Climax Molybdenum Company. Bound in loose - leaf manner, this reference book is chockfull of tables which form a volume almost an inch thick. Bulletin Hb-4.

Salt Bath

"Heating from the inside out" is what makes the Ajax-Hultgren salt bath furnaces practical. Ajax Electric Co. explains this new operating principle in an interesting folder. Bulletin Oy-43.

Chromel

A catalog has been issued by Hoskins Mfg. Co. covering Hoskins electric furnaces and Chromel elements, which provide uniform heat and automatic temperature control with excellent production and quality of work. Lulletin Ia-24.

Mo-W High Speed

J. V. Emmons, metallurgist for Cleveland Twist Drill Co. and largely responsible for the development of the molybdenum-tungsten high speed steels known as Mo-Max, has prepared a general description of these new steels. Bulletin Ka-103.

Panphot Microscope

A universal microscope with photomicrographic reflex camera is explained in this well illustrated booklet by E. Leitz, Inc. Points out applications and advantages of this system. Bulletin Db-47.

Duronze

An 80-page technical handbook covering the physical properties and applications of four high strength silicon bronzes pioneered by Bridgeport and sold under the trade name "Duronze alloys" has been released by the Bridgeport Brass Co. Bulletin Bb-163.

Centricast Boxes

The story of centrifugally cast carburizing and annealing boxes — their reason for being, method of production, properties, and advantages — is made extremely readable in a folder by Michigan Steel Casting Co. Bulletin Jy-84.

Defi Rust

Analysis and descriptive notes of nine types of heat and corrosion resisting steels made by Rustless Iron and Steel Co. are contained in a handsome folder. Bulletin Ha-169.

Alloy Castings

The "extra point" value of Michiana alloy castings is shown in a new booklet just released by the Michiana Products Corp. Typical installations are shown. Bulletin Nb-81.

Abrasive Cleaning

Comprehensive information on airless abrasive metal cleaning is contained in a book on the "Wheelabrator" Tum-Blast, a patented mechanical device made by the American Foundry Equipment Co. Bulletin Fa-112.

Hardness Testers

A handy thing to have around for anyone who does much hardness testing is a complete and detailed catalog of the universal line of hardness testers carried by Pyro-Electro Instrument Co., together with information on various specialized pieces of auxiliary equipment. Bulletin Fb-197.

Steel Protection

Attractively printed in copper and black, a new booklet on U. S. S. Copper Steel "A Little Copper In Steel Gives a Lot of Protection" has been published by the United States Steel Corp. Subs. Bulletin Nb-79.

Rust Preventative

How to prevent rust effectively is related in a bulletin issued by the Alox Corporation. Describes their method which is being used successfully in a wide variety of forms. Bulletin Nb-212.

X-Ray Examination

The application of X-ray examination and inspection of castings, welding, and food products, as well as practical X-ray crystal analysis, is completely described and strikingly illustrated in General Electric X-Ray Corp.'s new 34-page publication. Bulletin Dy-6.

Meehanite

A compact but complete specification chart gives the recommended grades of Meehanite metal for various service requirements. Complete physical properties and applications are included. Bulletin Da-165.

Rotoblast

A new blast cleaning machine eliminates the need for compressed air as the abrasive driving agent. Pangborn Corporation tells how a rapidly spinning wheel propels the abrasive by controlled centrifugal force. Bulletin Ox-68.

Tempering Furnace

Technical details and operating data on Lindberg Engineering Co.'s Cyclone electric tempering furnace, which has shown a remarkable performance record in steel treating operations, are given in Bulletin Fx-66.

Six Metals

"Six Minutes with Six Metals" is the interesting title of a well illustrated booklet which describes various metals produced by the International Nickel Co. Bulletin Nb-45.

Nichrome Containers

The important part that containers play in economical and dependable carburizing is well known to metallurgists and heat treaters. A Driver-Harris Co. bulletin on Nichrome carburizing containers should therefore not be neglected. Bulletin Ca-19.

Heat Resisting Al

Authoritative information castings, especially the nickel and straight chrom manufactured by General to resist corrosion and hig tures, is contained in Bu

Ni-Cr Castings

Compositions, properties, of the high nickel-chromiu made by The Electro Alloy heat, corrosion and abras ance are concisely stated in illustrated booklet. Bulleti

Ingot Production

"The Ingot Phase of Ste tion" is the title of a book the principles of quality in duction followed by ma known steel manufacturers mann Engineering Co. Bulle

EPI Microscope

The Zeiss EPI microscope illumination and observa opaque material has unlimi cations for observing opaq rial in dark field, bright polarized light. A descriptiv is published by Carl Zeiss letin Aa-28.

Bright Annealing

Various types of electric fired furnaces built by the Furnace Co. for bright-a wire, tubing, strip and oth ucts are described in a new folder. Bulletin Lb-30.

Cr-Ni Alloy Castin

Calite Chromium-Nickel Castings for Annealing Bases are described in a letin just released by the ing Company. Illustrates ty stallations and points out advantages. Bulletin Lb-26.

Gas Carburizing

A proven Muffleless burizing Furnace with Hypercarb Process for Steel is thoroughly describe colorful 4-page booklet is Continental Industrial Inc. Bulletin Lb-154.

Microtomes

Bausch & Lomb Microto Accessories are described tured in a 16-page booklet sued by that company. wide range of instruments plains their uses. Bulletin

Aluminum

Data on all the properties commercial forms of alumin contained in a new booklet leased by the Aluminum of America. Explains best each purpose. Bulletin Lb-54.

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Cold Finished Bar is introa colorful booklet just re- by the LaSalle Steel Com- Well illustrated, the booklet ains tables showing sub- ings made by the use of steel. Bulletin Lb-52.

cation Improve-nts

re research which com- portant improvements in of heavy-duty gear and fabrication is tabulated in page illustrated bulletin ued by D. A. Stuart Oil Bulletin Lb-118.

ic Furnaces

Furnaces suitable for light experimental and re- purposes over a wide range eratures and operating re- ts are described in a book- printed by C. I. Hayes, Inc. Lb-15.

Welders

nd improved General Elec- Welders are shown in a issued 16-page booklet available by the General Company. Well illustrated otographs and interesting Bulletin Lb-60.

nnealed Sheets

ple answer to the question Should I Use Republic Gal- ed Sheets?" is contained in esting folder just released Republic Steel Corporation. ut advantages and shows stallations. Bulletin Lb-8.

h Grain Size

illuminating paper "Which ize" appeared in the March nsactions of the A.S.M. A of this article is made avail- the Bethlehem Steel Com- Bulletin Lb-76.

-Mo Atmosphere

rful folder explaining how num steel can be heat without decarburization is ilable through the Surface ion Corporation. Points out ges of the new Char-Mo and explains its operation. Lb-51.

Boosters

ar Turbine Co. has published st time information concern- ancer gas boosters which en in successful operation in nts for several years. They standardized for handling of acid fumes, poisonous, or explosive gases. Bulle- 2.

Alloy Sling Chain

An illustrated bulletin explaining the advantages of the remarkable new nickel-molybdenum alloy used in high strength, heavy duty, heat treated alloy sling chains has been released by Joseph T. Ryerson & Son, Inc. Bulletin Lb-106.

Wetting Agents

The American Cyanamid & Chemical Corp. has just issued a 32-page booklet which describes the Aerosol Wetting Agents, new synthetic chemicals possessing remarkable wetting, penetrating, emulsifying and dispersing properties. Bulletin Fb-148.

Globar Elements

Globar Pin Type Non-Metallic Electric Heating Elements and Terminal Rods and Globar "AT" Type Non-Metallic Electric Heating Elements are explained and illustrated in two recent booklets issued by the Globar Division of the Carborundum Company. Bulletin Lb-25.

Lectromelt Furnaces

The story behind lectromelt furnaces is well told in this 48-page booklet issued by the Pittsburgh Lectromelt Furnace Corporation. Tells of development of this type furnace and describes recent improvements. Bulletin Db-18.

Wire Belts

An 8-page folder on Monel metal woven wire conveyor belts lists the advantages of Monel metal, illustrates some typical installations, and describes the various belt constructions that are available. Cambridge Wire Cloth Co. Bulletin Bb-178.

Metals for Corrosion

Fourteen varieties of Midvaloy corrosion and heat resisting metals are described in a detailed bulletin by The Midvale Co. Properties and applications are listed and illustrated. Bulletin Ca-160.

Tool Steels

Three little folders concisely describe three types of SKF tool steels, give their uses and recommendations for heat treatment. They are a carbon tool steel, an oil hardening steel, and a high alloy general purpose tool steel. Bulletin Ox-78.

Specialized Tester

The Rockwell superficial hardness tester is a specialized instrument for use where the indentation into the work must be kept shallow or of small area, yet sensitivity preserved. A supplement to Wilson Mechanical Instrument Co.'s catalog on the regular Rockwell tester tells all about it. Bulletin Sy-22.

Heat Treat Chart

Heat treaters everywhere should find a heat treating wall chart complete with S.A.E. specifications a very valuable addition to their shops. Published by Chicago Flexible Shaft Co., manufacturers of Stewart industrial furnaces. Bulletin Ka-49.

Ampco Metal

The six grades of Ampco metal, varying in hardness and physical properties but all possessing wear resistance, tensile strength and corrosion resistance, are described in a booklet which also lists its uses in modern industry. Bulletin Ka-175.

Nickel-Copper Steels

Exceptional resistance to corrosion and abrasion, increased tensile strength, and higher ductility are the qualities claimed for Youngstown Sheet & Tube Co.'s new series of Yoloy steels. A summary of properties and notes on their characteristics are contained in Bulletin Ox-93.

Laboratory Service

A new edition of "The Metal Analyst" tells about an organization established by Adolph I. Buehler specializing in the installation of metallurgical laboratories. The complete line of laboratory equipment marketed by Buehler is also catalogued. Bulletin Dy-135.

Program Controller

Variable temperature control over any period of time can be automatically carried through to completion without supervision by means of a control just publicised by the Wheelco Instruments Company. Bulletin Kb-110.

Magnet Steels

A very handsome booklet describes the permanent magnet steels and castings made by Simonds Saw & Steel Co., including Alnico and Alnic. Bulletin Ba-158.

Tool Steel Selector

A wall chart, 30 x 20 in., to be used as a means for selecting the proper type of tool steel is offered by Carpenter Steel Co. to tool steel users in the U.S.A. only. Bulletin Jx-12.

Welded Design

"How to Change Over to Welded Design for Profits" is the title of a 32-page profusely illustrated bulletin by Lincoln Electric Co., which is intended as an aid in applying electric welding to the design of machines and machinery structures. Bulletin Ab-10.

Die Blocks

A handy, small size spiral-bound leather notebook is a complete handbook on Heppenstall Company's die blocks. Valuable additional data are contained, as well as a few blank pages for memoranda. Bulletin Ca-122.

Vapocarb-Hump

Vapocarb-Hump, the triple-control method for heat treatment of steel, is described in a 36-page catalog issued by Leeds & Northrup Co., in which a special effort has been made to show how this method gives complete control of tool surface, shape and structure. Bulletin Cb-46.

Bessemer Steel

Jones & Laughlin Steel Corp. has for distribution reprints of the paper by C. C. Henning on "Manufacture and Properties of Bessemer Steel" that received the Robert W. Hunt Award of the A.I.M.E. during 1935. Bulletin Ca-50.

Carbonate Remover

A material for use in removal of carbonate from plating solutions is described in a new Electroplating Service Bulletin issued by Grasselli Chemicals Department of E. I. du Pont de Nemours & Co. Bulletin Bb-95.

Air Draw Furnace

Hevi-Duty Electric Co. offers a folder on their box type air draw furnaces for tempering, drawing, preheating, or annealing. Two types are available, one for temperatures up to 750° F., and one for 1250° F. Bulletin Nv-44.

Oven Furnaces

In a nutshell American Gas Furnace Co.'s improved oven furnaces offer controlled atmosphere, quiet operation, economy, are over and under-fired and bottom vented. Described more fully in Bulletin Aa-11.

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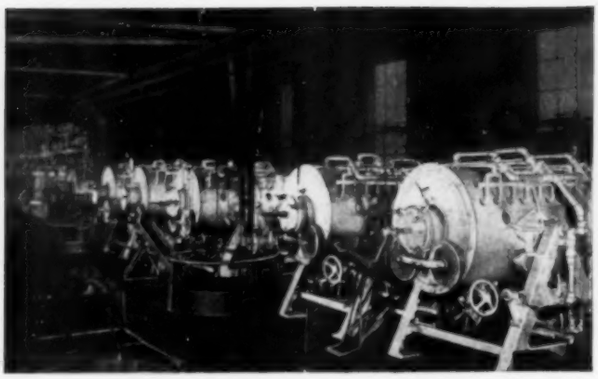

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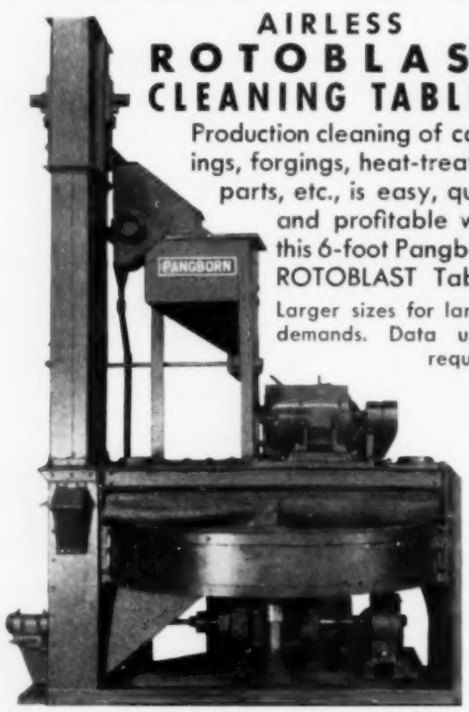

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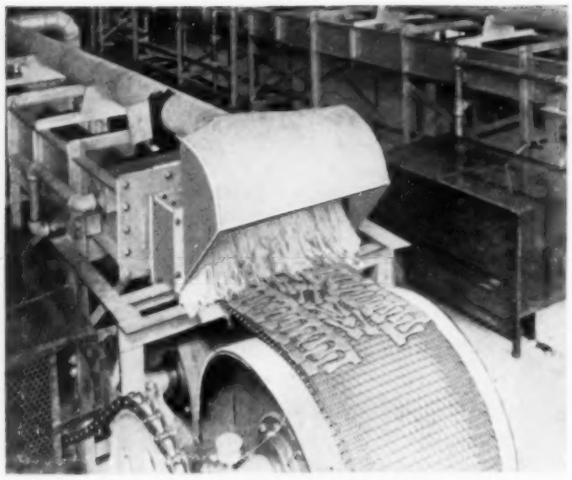

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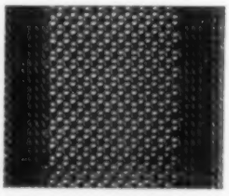

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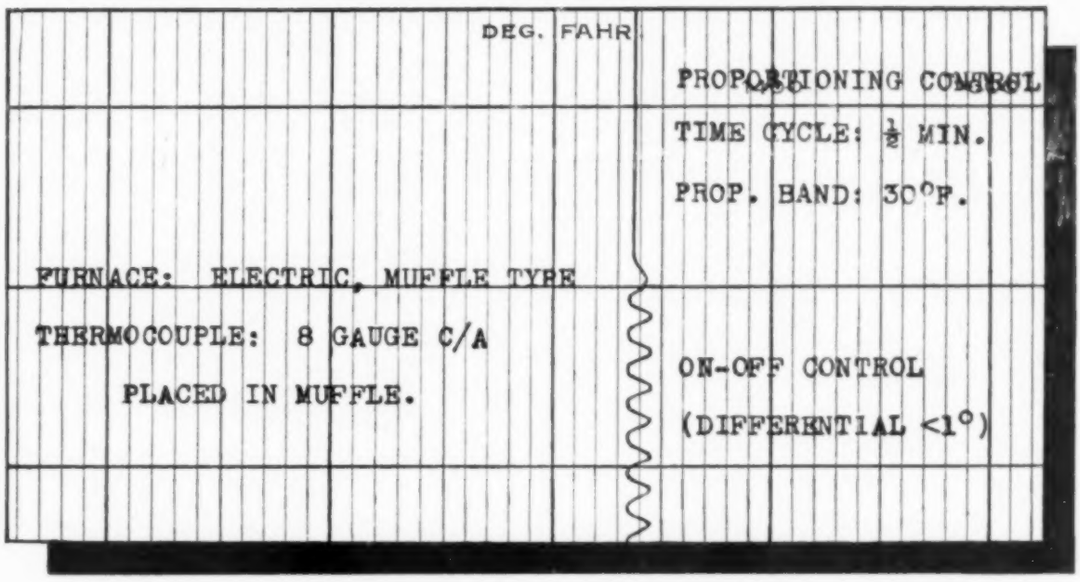

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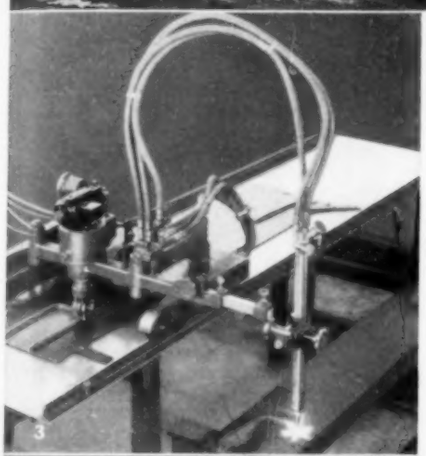
OXWELD CM-15 CUTTING MACHINE

. . . shapes small parts economically



WITHIN its cutting range—18 inches in width by 60 inches in length—the Oxweld CM-15 Portable Shape-Cutting Machine offers flame-cutting applications comparable to those of the larger Oxweld shape-cutting machines.

1. CM-15 flame-cut parts made possible much of the strength and efficiency in the unit construction of this tractor.

2. These are some of the flame-cut tractor parts ready for assembly and fabrication.

3. Here the CM-15 is shaping one of the three steel channels that form the tractor frame and hold the rollers in alignment.

4. Innumerable small shapes such as wrenches can be quickly cut to size on the CM-15 Machine by hand tracing.

5. Note the sharp, clean contours of these flame-cut shapes—many of which were put into service without further finishing.

6. Dual blowpipe operation of the CM-15 Machine, equipped with a circle-cutting attachment, speeds the cutting of blanks.

7. As the templet follower moves around the templet, the blowpipe accurately shapes a rocker arm.

A salesman from the nearest Linde office will gladly call concerning any application of the CM-15 which you may have in mind. Descriptive bulletin on request.

The words "Linde," "Prest-O-Lite," "Oxweld" and "Union" are trade-marks.

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Unit of Union Carbide and Carbon Corporation

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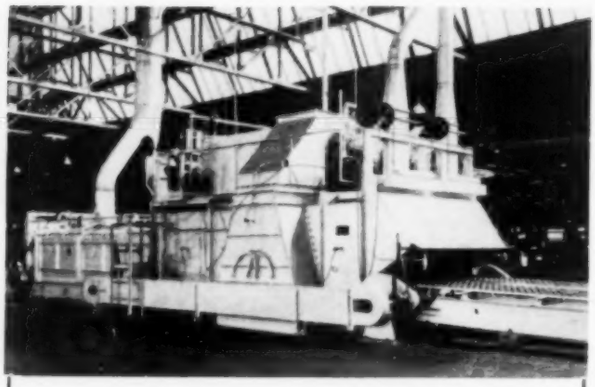

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June 7, '32. Others Pending

The "Alnor" pyrometer controller operates by fundamental radio principles. The controlling is done by changing the capacity of a condenser in an oscillating circuit. This gives hairline accuracy at split-second speed.

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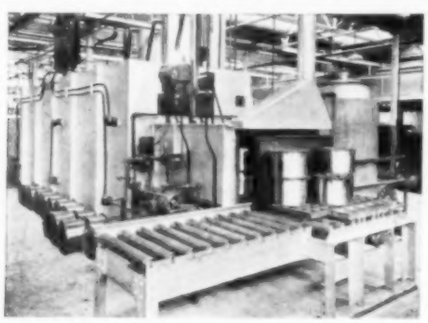
Coiled wire, as well as wire on small spools and large reels, is successfully handled in these furnaces. No water seals, steam or vapor of any kind is used, thus staining is entirely eliminated and no drying necessary. The wire is discharged from these furnaces uniformly annealed, absolutely bright and dry, ready for shipping, further processing or fabricating. The installation shown below is one of several types of electric and fuel-fired furnaces we have developed for the wire industry.



A special atmosphere continuous pusher type furnace for bright annealing both heavy and fine cop per wire on large reels, on spools and in coils

Other recent installations include furnaces for bright and clean annealing brass, nickel silver and copper wire; improved pit type furnaces for normalizing rod and bright annealing steel wire in coils, as well as furnaces for scale-free hardening bolts, springs, etc., furnaces for billet heating, bright annealing tubing, strip, stampings; carburizing, copper brazing and other heating and heat treating processes.

If you are interested in improving the quality of your anneal or heat treatment, increasing production or are contemplating any changes or additions to your furnace equipment, our engineers will be glad to work with you. We specialize in building production furnaces to fit the customer's specific requirements — for any heating process — for any product or production.

Ask for 8-page folder showing various types of electric and fuel-fired furnaces we have built for bright-annealing wire, tubing, strip and other products.

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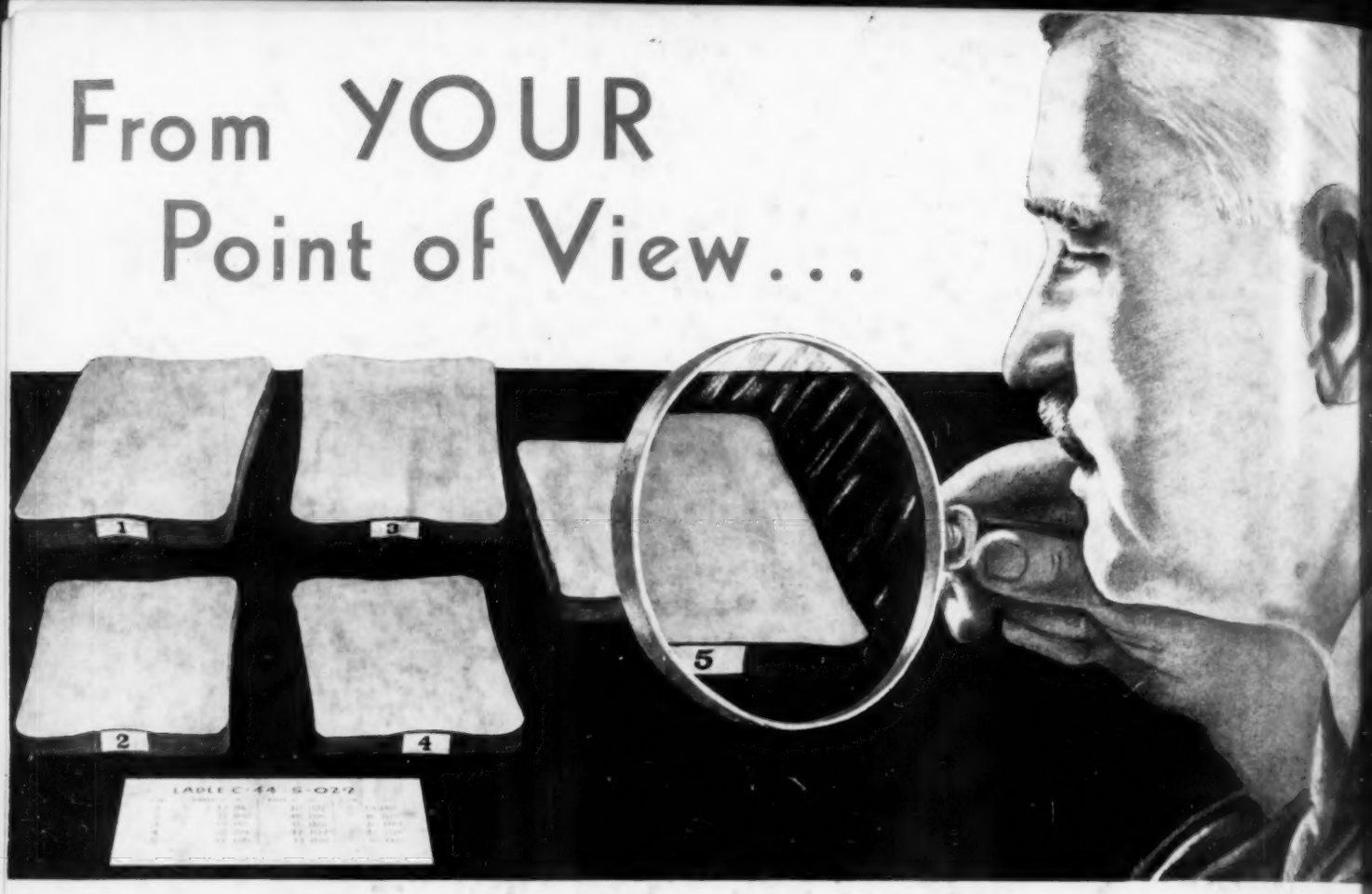

ETCHED SLICES OF 13-19 BLOOM
-44 CARBON FORGING STEEL
ROLLED FROM 22"-24"-8600# INGOT
Gathmann Multi-Tapered Type

CUT No. 1	81%	FROM	INGOT	BUTT
" " 2	70%	"	"	"
" " 3	50%	"	"	"
" " 4	25%	"	"	"
" " 5	1¼%	"	"	"

A Suggestion to the Steelmaker

At what temperature are your ingot molds at the time of teeming? For satisfactory mold life and for good surface and interior structure in the ingot, they should be between 200° F and 300° F when teemed.

A mold that is too cold may cause both pitting and cold shuts on the ingot surface; while a mold that is too hot will delay solidification of the ingot, thereby increasing segregation and possibly causing an incompletely solidified ingot to get into the soaking pit. And incompletely solidified ingots usually result in cokey centers in the product.

Molds should be rotated so that there is sufficient time between heats for cooling to at least 300° F. A new mold or one that has been out of use should be preheated to at least 200° F before teeming.

These are small precautions that pay big dividends.

IF YOU ARE AN EXECUTIVE, responsible for sales and profits, your point of view naturally tends first toward a consideration of costs. The metallurgist, responsible for quality in the product, will consider fitness of specification, uniformity of analysis and soundness of structure in the steels produced under his direction.

There is no conflict between these points of view when the ingot mold selected for your practice is the multi-taper type Gathmann big-end-up mold . . . it gives the low net production costs the executive must have and it satisfies the metallurgist's most exacting requirements.

Savings in production—thru higher ingot-to-bloom yields and decreased rejections of semi-finished and finished products—average about fifty dollars for every dollar invested in royalty on these new patented molds.

The etched blooms in the illustration were rolled from an ingot of this type. They were exhibited at the recent Metals Exposition in Detroit, and hundreds of steelmen pronounced them finer than anything they had previously seen.

Give us an opportunity to demonstrate to you the multi-taper mold in your own practice.

The Gathmann Engineering Company, Catonsville, Baltimore, Md

GATHMANN INGOT MOLDS